carolina planning

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Introduction

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Bruce Stiftel

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provides a needed planning perspective

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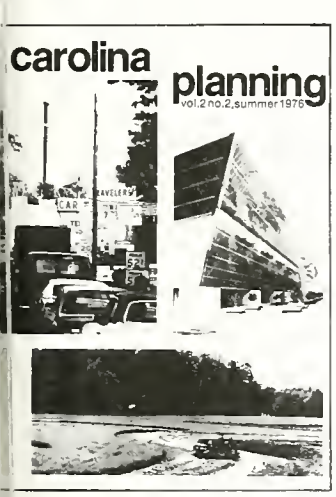

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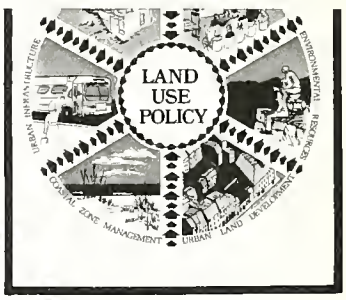

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Shifting Urban Policy Targets: Impacts on North Carolina and the South

According to the press, the states of the Snowbelt are involved in a "new civil war" with the states of the Sunbelt.[1] Governors have become generals, defending their regions. Skirmishes are fought in the North and South; while the major battle goes on in Washington, D.C. Battalions of regional interest groups are marshalled, each firing broadsides of research and policy analysis.[2] Computers are the primary engines of war, supplying ammunition for policy thrusts and counterthrusts. To the victors go the spoils in the form of new federal funding formulas.

Is this simply another media event, trying to capture public attention by overplaying political rhetoric? Maybe so, but beneath the rhetoric a significant shift in federal policy is being engineered which will have lasting consequences for the citizens and public officials of North Carolina and other developing southern states. Under the guise of "targeting" federal funds on urban problem areas, the present administration is systematically changing the rules for allocation of grants so as to favor older, declining cities, mostly in the Northeast and Midwest, while neglecting newer, growing southern and western areas.

While the funding targets are being changed, the funding procedure is not. The block grant approach which replaced categorical aid programs remains in place. What this means is that money is being "thrown at" problem areas, without a corresponding effort to identify root causes and to remedy the dangerous possibility that these old declining cities will become wards of the federal government, dependent on funds from Washington to carry out even their normal daily operations. Richard Nathan, of the Brookings Institution, recently testified that Cleveland's federal aid of $110 million amounts to 90 percent of its $122 million general fund expenditures.[3] The *New York Times* reported that in Detroit a fifth of the police officers, almost half of the garbage collectors, and over ten percent of the firefighters were being paid with federal money intended to stimulate the economy; they concluded, "what was intended as short-term, emergency relief seems destined to become a permanent part of the national economy" (Rosenbaum 1977, pp. 1, 66).

This new welfare policy for declining cities maintains rather than solves problems. It substantially and permanently reduces assistance needed in other areas. While it is not yet possible to document the lack of effectiveness of the new policy in problem solving, we can show what is likely to happen in allocation of funds through the example of the recently amended Community Development Block Grant (CDBG) program.

Community Development Block Grant Formula Changes

The primary goal of the Housing and Community Development Act is:

> . . . the development of viable urban communities, by providing decent housing and a suitable living environment and expanding economic activities, principally for persons of low and moderate income (Advisory Commission on Intergovernmental Relations 1977, p. 49).

The act consolidated most of the U.S. Department of Housing and Urban Development (HUD) categorical programs into a single block grant. These included: grants for urban renewal, neighborhood development, Model Cities, water and sewer facilities, neighborhood facilities, public facilities, open space—urban beautification—historic preservation, and rehabilitation loans.

The original CDBG distribution allocated 80 percent of the funds to Standard Metropolitan Statistical Areas

Figure 1

Community Development Block Grant Program
1976 and 1978 Entitlements by Census Regions
(1000's of dollars)

Area	1976	1978	Percent Change	Benefit From Dual Formula?
United States Total	$2,699,000	$3,405,500	+26.2	
Northeast:	762,169	959,018	+25.8	Yes
New England	217,657	212,285	−2.5	Yes***
Middle Atlantic	544,512	746,733	+37.1	Yes
North Central:	622,062	871,047	+40.0	Yes
East North Central	419,347	629,521	+50.1	Yes
West North Central	202,715	244,526	+20.6	Yes
South:*	849,023	971,243	+14.4	No
South Atlantic	413,672	446,672	+8.0	No
East South Central	178,448	206,552	+15.7	No
West South Central	256,903	318,019	+23.8	No
West:	412,907	514,035	+24.5	No
Mountain	100,422	110,747	+10.3	No
Pacific**	312,485	403,288	+29.1	No****
U.S. Territories	52,838	90,196	+70.7	No****

NOTE: Detail may not sum to total due to rounding. U.S. total does not include Secretary's discretionary fund, whose allocation is not formula-based.

*The SGPB South is the Census South region less Delaware and the District of Columbia.

**Including Alaska and Hawaii.
***Would have lost more under the old formula.
****Increase would have been less under the new formula.

Source: U.S. Department of Housing and Urban Development (1976) and U.S. Department of Housing and Urban Development (1977).

(SMSAs) and 20 percent to non-SMSAs. Within the SMSA category funding was based on a formula with three weighted factors: 25% population, 25% housing overcrowding, and 50% poverty. In addition, these areas were protected from decreases in their previous levels of funding under categorical programs by a "hold harmless" provision determined by the average funds received during the preceeding five years.

Hold harmless provisions were temporary. Most of these provisions were intended to begin phasing out in fiscal year 1978, with complete phaseout over a three year period. However, as it was realized that the phaseout of hold harmless would result in major funding cuts for older, declining cities under the original formula, pressures were mounted to ensure that the hold harmless funding cuts did not occur.

A coordinated effort by HUD, the Brookings Institution and the Northeast-Midwest Coalition resulted in congressional approval of a new metropolitan area funding formula designed to favor the declining cities. (Nathan *et al.* 1977). The new formula's weighted factors are 20% growth lag (behind the national growth rate for metropolitan cities since 1960), 30% poverty, and 50% age of housing (only housing built prior to 1939 is counted). Under a dual formula approach, the recipient government may choose either the original or the new formula, whichever is most favorable.

The new formula represents a victory for those critics of the 1974 Act who felt that old central cities were shortchanged initially. It represents a defeat for those who felt that small cities and developing counties also were shortchanged. In its evaluation of CDBG, the Advisory Commission on Intergovernmental Relations noted:

> By any construction of the legislation's objectives and by even a cursory reading of the implementation record to date, the larger, older central cities, and the small cities and counties of metropolitan areas have or will have a legitimate basis for claiming unfair treatment (Advisory Commission on Intergovernmental Relations 1977, p. 87).

The Commission recommended a revised funding allocation to treat *both* older deteriorating cities and small communities in metropolitan areas more equitably. Only half of this recommendation was adopted, as supporters of declining cities promulgated an image of "suburban tilt" in the original legislation and successfully lobbied to change the major factor in the new formula from poverty to age of housing.

Figure 2

Community Development Block Grant Program
1976 and 1978 Entitlements for Fifteen Southern States
(1000's of dollars)

State	1976	1978	Percent Change	Benefit From Dual Formula?*
Alabama	49,059	60,341	+23.0	No
Arkansas	31,842	30,442	−4.4	No
Florida	80,792	109,024	+34.9	No
Georgia	64,091	65,635	+2.4	No
Kentucky	38,418	47,443	+23.5	No
Louisiana	42,281	62,576	+48.0	No
Maryland	50,999	53,085	+4.1	Yes
Mississippi	32,915	36,745	+11.6	No
North Carolina	65,850	64,182	−2.5	No
Oklahoma	39,972	36,636	−8.4	No
South Carolina	26,542	30,477	+14.8	No
Tennessee	58,056	62,023	+6.8	No
Texas	142,808	188,365	+31.9	No
Virginia	61,406	60,759	−1.1	No
West Virginia	15,039	23,004	+53.0	Yes
South Total	800,070	930,737	+16.3	
U.S. Total	2,699,000	3,405,500	+26.2	

NOTE: Detail may not sum to total due to rounding, U.S. total does not include Secretary's discretionary fund.

*Increases in allocations in states that do not benefit from the dual formula result from rapid population growth (as in Florida and Texas) and/or from the spread effect of block grants as opposed to categorical grants.

Source: U.S. Department of Housing and Urban Development (1976) and U.S. Department of Housing and Urban Development (1977).

Noting that the program is at a crossroads, the Commission asked: "should the focus of the CDBG program shift from the renewal and development of large urban areas to the renewal and development of all the nation's cities" (Advisory Commission on Intergovernmental Relations 1977, p. 90). They took the position that Congress should give special attention to the needs of the small cities. This did not happen. Note that the new formula completely drops the overcrowded housing factor, a feature of much sub-standard housing in the South, but not in the abandoned housing areas of northern central cities; that it downgrades the weight of the poverty factor, which reduces the influence of the much lower per capita income of the South; that it gives maximum weight to the age of housing factor, which does not correlate with accepted indicators of urban stress such as lack of plumbing or non-white occupancy; and that it introduces a new growth lag factor, which is tailored to fit the cities of the Northeast which have been losing population since the 1960's.

The disproportionate impacts of the formula changes can be seen in Figure 1, which shows the funding changes for various regions. Some increases occur in nearly all regions due to the allocation of an additional $600 million for 1978, but the lion's share of the increase is estimated to go to Middle Atlantic states of the Northeast Region and to the East North Central states of the North Central Region. Increases in the Middle Atlantic and East North Central areas alone account for $412 million, or over two-thirds of the additional 1978 allocation. Furthermore, only two Census regions, the Northeast and the North Central, benefit as a whole from application of the new formula. The South and the West do not.

An unanticipated consequence of the new formula is that it provides a windfall in federal funds to a number of cities which do not fit the objectives of the Act to benefit persons of low and moderate income. For example, Oak Park, Illinois, the middle class suburb of Chicago known for its concentration of Frank Lloyd Wright houses, gains a very large windfall. Despite the fact that only 3 percent of its families have incomes below the federal poverty level, Oak Park's entitlement goes up over 400 percent from $347,000 in 1976 to $1.75 million in 1978. Under the old formula, it would have been entitled to only $565,000 in 1978 (U.S. Department of Housing and Urban Development 1976; U.S. Department of Housing and Urban Development 1977).

North Carolina, on the other hand, does not benefit from the dual formula in 1978. North Carolina cities receive higher allotments under the original formula, which shows the geographic bias of the new formula. Furthermore, in

1978, North Carolina cities as a group will receive only 97.5 percent of their 1976 funding, while the nationwide funding level will be up to 126.2 percent of the 1976 level (See Figure 2).

North Carolina is one of four southern states whose allocations decrease between 1976 and 1978. Only two southern states benefit from the new formula and the South as a whole benefits from an increased appropriation far less than the rest of the U.S. The South's allocation increases about 16 percent while the overall U.S. increase is about 26 percent. For most of the South, the choice implied in the dual formula is no choice at all, due to the new formula's heavy reliance on age of housing and growth lag factors.

Future Impacts

Similar changes will be proposed for other federal funding programs in the coming months. Among the programs likely to be affected are the Elementary and Secondary Education Act, the Comprehensive Employment and Training Program, Housing Assistance, Aid to Families with Dependent Children, Medicaid, General Revenue Sharing, Local Public Works, National School Lunch Program, and Vocational Rehabilitation. Each of these programs could be targeted toward "distressed cities" if the President's urban policy group's recommendation is accepted. This draft report calls for a sharp change in federal policy, deliberately steering federal funds toward economically distressed areas and away from other parts of the country (*Wall Street Journal* November 8, 1977). This new policy could be reflected in creation of an Urban Bank to aid cities with high unemployment rates, provisions for tax exempt industrial revenue bonds limited to areas of high unemployment, tax reforms aimed at encouraging central city revitalization, an energy development bank for the Northeast, and an energy plan that boosts costs in the energy-producing Sunbelt. When the growth-restricting provisions of the federal air and water quality standards are added in, the array of federal policies unfavorable to the developing parts of the country is large.

It is not as though no federal aid were being rendered to the Northeast. Extreme statements by some commentators about the "hemorrhage" of tax dollars from the Snowbelt to the Sunbelt notwithstanding, a recent study by the Library of Congress showed that between 1950 and 1975 the northeastern states went from last to first place in per capita federal aid (Library of Congress 1977). The U.S. average in 1975 was $229 per capita, the Northeast received $260, the West $241, the South $218, and the North Central $197.

Impacts of the proposed policy shifts could change the population projections now envisioned for North Carolina and the South. With the slowing of growth in the West, over half of the nation's growth is now expected to take place in the fifteen southern states between 1980 and 2000. North Carolina's population is projected to increase to almost 7.5 million in the year 2000, a 25 percent increase over its 1980 population (Godschalk 1977). However, efforts at the redirection of funding now under way in Washington might mean a moratorium on southern growth, at least until these policies are changed.

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Ed. Note: The Southern Growth Policies Board is an interstate organization serving 15 southern states from Maryland to Texas.

Notes

1. For a sample of the Sunbelt/Snowbelt coverage, see: Gurney Breckenfeld, "Business Loves the Sunbelt (and Vice Versa)," *Fortune*, June 1977; "The Second War Between the States," *Business Week*, May 17, 1976; and "Federal Spending: The North's Loss and the Sunbelt's Gain," *National Journal*, June 26, 1976.
2. Northeastern and midwestern interest groups include: Council of Northeast Governors (CONEG), CONEG Policy Research Center, Council for Northeast Economic Action, Northeast-Midwest Economic Advancement Coalition (over 200 members of the U.S. House of Representatives), New England Congressional Caucus, New England Economic Research Office, and Great Lakes Economic Action Council. Southern and western groups are: Southern Growth Policies Board and Western Governors Policy Office.
3. Quoted in *Practicing Planner*, September 1977, p. 11.

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Planning for Natural Diversity: The N.C. Natural Heritage Program

For conservationists in North Carolina, it is an exciting time. In recent months, a four million dollar purchase of Currituck Banks sanctuaries has been made possible by the largest conservation gift in the history of American foundations. The preservation of the Green Swamp national natural landmark has been achieved through one of the largest land donations by an American corporation. Fund raising and negotiations are in progress to acquire more of North Carolina's finest natural areas. A strong conservation spirit is gaining force. Conservation in North Carolina is scoring victories through an unusual alliance of environmentalists, business, universities, foundations, and government. Many of the current achievements are spawned by the creation of two young and parallel efforts: the North Carolina Nature Conservancy and the North Carolina Natural Heritage Program.

North Carolina is blessed by a magnificent natural diversity. But it is threatened. Habitats of rare and endangered plants or animals, undisturbed ecosystems, and other areas of special ecological interest are of great concern. These resources are important for their scientific, educational, recreational, ecological, economic, cultural, and inspirational values.

Natural diversity is commonly the loser in our society's quest for prosperity and urbanization of the land. North Carolina's natural heritage, while still rich, is a pale remnant of the past. Each year a bit more of the natural landscape disappears to development. Our wildlife, particularly the native non-game species, is pushed back into ever more isolated enclaves. State scientists and

resource managers list several hundred native plant and animal species whose survival is endangered or threatened. Prime instances of forest and other ecological associations are reduced to the point of being artifacts of the original landscape.

Few public decision-makers, including planners, understand the importance of conserving natural diversity. Fewer still recognize that existing parks, refuges, and publicly-owned natural areas preserve no more than a fragment of our natural heritage. Local land use plans, likely as not, propose future development of the critical natural areas that remain in private ownership. Management plans for lands in public ownership too frequently are destructive of vulnerable ecological resources.

The North Carolina Natural Heritage Program is designed to inventory the state's critical elements of natural diversity and to identify those natural areas most deserving protection. Established in late 1976 with assistance of the Nature Conservancy and private foundation grants, the Natural Heritage Program is a unit of the Division of Parks and Recreation within the State's Department of Natural Resources and Community Development. Its inventory involves collection of data on the occurrences, location, rarity, ownership, protection and management status, and site qualities for the State's most critical elements of natural diversity—habitats of endangered and rare species, mature and high-quality examples of plant communities, unique geologic features, and important wildlife habitats.

Our approach recognizes that a rational decision process must determine which parts of the natural landscape most merit preservation and which sites most warrant investment of limited financial resources. The inventory produces an index of relative rarity showing which natural elements have fewest occurrences and which are least protected. Direct comparisons of quality, viability, and defensibility can be made on the basis of real data, as opposed to the subjective judgments that too often prevailed in the past. Analysis of the data and follow-up field surveys permit us to determine the sites that most merit preservation. After identifying the best prospects, we can make a detailed investigation and develop a preserve proposal, protection strategies, and management plans.

Natural heritage programs have been established at the request of ten state governments by the Nature Conservancy, a national citizen-based conservation organization. The Nature Conservancy has developed a system for these states to conduct the ecological inventory, to manage and analyze assembled data, and to implement protection strategies. As the programs are incorporated within state agencies, the system continues to accumulate inventory information, to refine protection priorities, to promote public concern for conservation, and to preserve ecologically significant areas.

The Nature Conservancy has helped preserve over a million acres of natural lands in the United States, including over 85,000 acres acquired in North Carolina. The Nature Conservancy in North Carolina has acquired land for the protection of such varied areas as Great Dismal Swamp, Jockey's Ridge, Roan Mountain, Chowan Swamp, Eno River, Stone Mountain, Green Swamp, Bird Shoal Islands, and Currituck Banks. The North Carolina Nature Conservancy, a branch of the national Nature Conservancy, is directed by trustees and advisors composed of leading businessmen, conservationists, financiers, lawyers, scientists, and politicians. Its preservation projects, many of which are in progress, are based upon priorities set by the Natural Heritage Program. Its purchases are sometimes in cooperation with public agencies and sometimes private actions. Working with public agencies, universities, and other conservation groups, the Conservancy offers North Carolinians the opportunity to contribute to the protection of the state's natural diversity.

The value of the Conservancy's assistance in establishing natural heritage programs within state governments, rather than within the private or academic sectors, is that states can potentially bring tremendous protection capabilities to bear. Also, as units of government, the programs provide for effective interaction and cooperation among public agencies, and permit the long-term maintenance of an ecological information system that public agencies can best afford. In a state where land conservation traditionally has been promoted by private citizens, a cooperative effort between government and the private sector offers the greatest possibility of success.

The Natural Heritage Program has developed a sophisticated yet economical data management system that provides an information and planning tool for use in decision-making. Information on all occurrences of critical natural features are recorded in USGS topographical maps, computer storage and retrieval bank, and cross-referenced manual files.

The endangerment of our natural heritage is largely unnecessary since there are nearly always alternatives to destruction, but only if decision-makers are well-informed. In the past, there has been a lack of (1) sufficiently detailed environmental information focused on natural elements, (2) adequate methods for evaluating this information and setting sound protection priorities, and (3) a balanced and practical system for efficiently and effectively protecting the recognized critical areas. There has been a lack of organized, coordinated, and accessible information on the existence, location, condition, and protection status of elements of natural diversity. The Natural Heritage Program meets these needs.

The Natural Heritage Program can help assure effective allocation of resources, while avoiding development conflicts. Our information is made available freely for the use of other public agencies, public works planners, local governments, scientific research, educational, and conservation programs. We believe that by providing natural diversity data to others, we contribute to improved management of natural areas in public ownership, environmental impact assessment, and development planning. The timely input of ecological information in decision processes will serve to avoid unnecessary natural resource conflicts or destruction of significant natural elements.

Public conservation agencies use our data for their resource inventories and planning. The U.S. Forest Service uses our data for its North Carolina forest inventories and unit planning. The Fish and Wildlife Service uses our information for establishing priorities for protection and acquisition of wildlife habitats in North Carolina. We have provided natural diversity information to the National Park Service for developing management plans over the Great Smoky Mountains and Cape Hatteras national parks and for assessing potential national natural landmarks. Our program provides data management for the NC Wildlife Resouce Commission's endangered species protection program. We contribute to the Coastal Resources Commission's determination of coastal areas of environmental concern, in which development is regulated. We aid the Division of Environmental Management in identifying natural areas in its water basin development plans. We contribute to the information services of the Land Policy Council. The Division of Parks and Recreation incorporates natural diversity data in its park master plans, environmental assessments, and state outdoor recreation plan.

Heritage information is also used by local governments for resource inven-

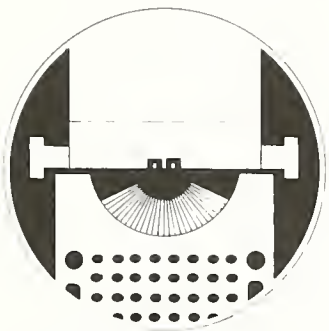
tories and land planning. The Piedmont Triad Council of Governments wrote that:

> The PTCOG views the N.C. Natural Heritage Program as an irreplaceable organization in compiling and distributing this information from one central location. Most councils of governments and local governments have neither the money nor the expertise to perform this work. Without the Heritage Program, we fear development will unknowingly deface or destroy some of the natural beauty and uniqueness of North Carolina.

The Natural Heritage Program participates in environmental impact assessment reviews of proposed development projects and also provides natural diversity data to development agencies for project planning. This service adds a new dimension to the State's review capabilities and is appreciated by the development agencies.

We have a better prospect for protecting our rich habitats of native species and remnants of the original natural landscape as a result of the inventory and protection planning program. The Natural Heritage Program has demonstrated its effectiveness for contributing ecological data to a range of decisions and for identifying the State's most significant natural areas. The Nature Conservancy has focused public efforts to protect those areas. Our natural heritage can now potentially be protected through cooperation of government, private organizations, and concerned citizens.

Charles E. Roe
Coordinator
N. C. Natural Heritage Program
N. C. Department of Natural Resources and Community Development
Raleigh, North Carolina



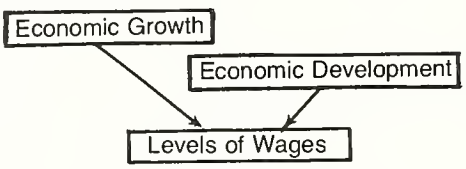
Letters

North Carolina Development Policy

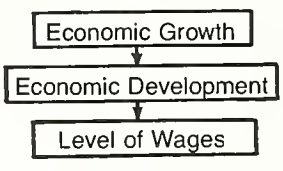
The article by Mark Horowitz and Thomas Rogers in the fall 1977 issue of *carolina planning* is one of the best quantitative analyses of economic development factors in North Carolina I have seen.

The article proposes to break down the determinants of wages into two components—an economic growth component and an economic development component. In light of the current North Carolina policy which concentrates solely on economic growth factors, this disaggregation is useful in that it highlights the need to consider economic development variables. Although the consideration of economic development factors is a step in the right direction, the author's model still treats economic growth factors as independent forces which influence the level of wages. The authors reject the neoclassical explanation that "economic growth is the necessary and sufficient condition for development" but do not take the final step—that economic growth has no independent effect on wages and only provides a potential for increases in wages—a potential which is activated by the development factors.

In terms of their model, after developing composite variables related to economic growth and economic development, the multiple regression model tests the relative importance of economic development and economic growth as two separate factors. Schematically:



I would contend that the literature by Seers and Emmanuel which the authors cite instead supports an alternative formulation:



whereby economic growth has *no* independent effect but rather exists as a potential which acts through the economic development factors. Increased production—either through the installation of new plants or through increased productivity—provides more surplus to be divided between capital and labor. However, the "bigger pie" thus produced is controlled by the captial owners who then divide it between capital and labor. The division of this product is influenced by the economic factors—level of unionization, income inequality, and urbanization.

This model could be tested by stratifying the observations by level of economic growth and running the regression. The influence of economic development variables (as measured by the beta coefficients) should be higher in the group with a high economic growth level and lower in the low economic group, indicating that the level of economic development activates the potential for higher wages generated by economic growth.

The conclusions reached by the authors are certainly justified—that the state of North Carolina must shift its emphasis to people-oriented development policies and should remove institutional barriers to worker organization that presently exist—but I would contend that their case is stronger than is presented. Not only do economic development factors influence the level of wages, but they are of primary importance. In terms of raising the level of wages, the economic growth experience in North Carolina has been wasted to the extent that economic development factors have been too low to activate the potential for higher wages created by economic growth.

I should also note that the article "Institutional Determinants of State Wages Differentials," which the authors attribute to me, was in fact written by Robert Crow.

Peter Stroup
Division of Community Employment
North Carolina Department of Natural Resources & Community Development

carolina planning *welcomes letters and submissions to* **carolina forum.** *Pieces in* **forum** *report on important planning activities and present opinions on planning issues. Address letters and submissions to: Editor,* **carolina planning,** *Department of City and Regional Planning, University of North Carolina, New East 033A, Chapel Hill, NC 27514.*

Urban Land Use Policy in an Era of Constraints

These are times of widespread interest in "land use." But as land use has gained currency, it has come to mean different things to different interest groups. To some, it has to do with national resource use—the use of land for agriculture, grazing, forestry, extraction, or wildlife sanctuaries. To others, it has to do with use of state resources—the seacoast, lake country, mountains, or other areas of critical environmental concern. And to still others, it refers to land development in the urban scene for industrial, business, residential, or other uses. There are both positive and negative associations with land use. To many, land use is a tangible reflection of economic vitality and strength; to others, it means problems or destructive tendencies in man's activities.

One common denominator to these different perspectives is the interface between growth and finite resources—the need to come to terms with environmental overloads, energy resource shortages, and other resource problems that may adversely affect the economy and the well-being of millions of households. The seventies will undoubtedly be marked as a watershed, a time when Americans came to realize that many finite resources long taken for granted were after all limited, many of them nonrenewable or irreversibly damageable. In this essay, I shall be less concerned with this precarious balance as a problem than with governmental responses to this problem and how these impact on land use policies of local governments. Let me begin with the initiatives of the federal government and work downward to the local level.

National Initiatives

No framework of urban land use controls directly mandated by Congress as such exists today. Under the division of powers in the American system, it is unlikely there ever will be one. Regulation of non-federal lands is a function left to the states, and federal intrusion on this function occurs only when there is an overriding national interest involved. Yet federally financed facilities under housing, transportation, health, education, and other categoric programs have a profound effect on land use. Also, continuing aid under these programs is often conditioned on the effectuation of supporting adjustments in local land use regulations. More recently new federal initiatives in environmental protection and resource conservation portend pressures to bring local land use regulatory measures in line with national policies and standards. It is the intergovernmental context within which these initiatives are exercised which is the main focus of the discussion which follows.

As we enter an era of shortages, resource use strategies have taken two forms. The first is to turn to an alternative resource, while holding steady to traditional consumption levels. When the technology has not been developed or when time schedules for achieving the needed technology preclude any feasible or immediate substitutions, national policy follows a second-choice strategy in which consumption levels are brought into accommodation with a strict conservation policy, at least until technological developments permit a return to earlier consumption levels. In view of the extensive and diffuse patterns of interdependence that exist among the various sectors of the economy using the same resources, the likelihood of finding solutions under the first strategy is becoming less certain. Not only are substitutions becoming more difficult to develop, but the disruptive effects that substitutions have on the economy are proving more difficult to eliminate.

Material shortages are only part of the reason that national policy has shifted to a stricter conservation

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This is an abridged form of Chapter 1, "Land Use Policy Perspectives," to appear in the forthcoming revised edition of **Urban Land Use Planning** *by the author and Edward J. Kaiser. This version is reproduced with permission of the University of Illinois Press.*

orientation in resource use. The environmental problems have been another major influence. In the domestic scene, these two not unrelated resource problems are exerting a marked influence on national policy. But, as recent history has shown, the methods for dealing with the two problems are not always compatible. In dealing with the energy problem, national policy shifted haltingly among the three strategies—a return to coal as a fuel in order to maintain consumption levels at their ascending growth rates, the use of nuclear reactors, and a policy course which aimed to adjust consumption levels to achieve some intermediate accommodations to the energy problems. All have environmental implications. As the events have shown, mass consumption habits and the nation's economic apparatus do not respond easily to these tradeoffs. Tremendous pressures were placed on Congress, and as a result, policy is a mix of all three strategies.

> "One common denominator to these different perspectives is the interface between growth and finite resources—the need to come to terms with environmental resource shortages, and other resource problems . . ."

Sectoral Organization of Functions

One outstanding characteristic of national policy has been a strong tradition of developing resources on a function-by-function basis. In both legislative conception and line agency implementation, agriculture, forestry, grazing, fish and wildlife management, mining, water resource development, recreation, transportation, and urban development have been conceived and developed largely as single-function programs. Good efficiency reasons exist for organizing single objective activities as separate programs, but when there is no policy-coordinating mechanism for examining the interface of sectoral activities in a multiple objective perspective, problems crop up. Spillover effects, secondary impacts, or outright conflicts can be taken into account by the agencies involved only after the fact. Although interagency coordinating committees do sometimes negotiate solutions, the forces for maintaining the autonomy of these agencies are strong. Each operates under policies largely developed through a paternalistic committee system in Congress responding to a fairly well-defined constituency of program beneficiaries—often particular regions or states.

Over the years, efforts to secure cross-sectoral coordination have been consistently rebuffed by various lobbies and coalitions of interest groups. As its succession of names implies, the National Resources Committee, Board, and Planning Board (NRPB) had rough going in the first federal effort at simply marshalling knowledge about the state of the nation's resources. It was seen as a threat to the autonomy of the agencies charged with overseeing these resources. Congress scuttled this initiative in 1943, after a decade of effort.

While an NRPB pattern of monitoring trends has not reappeared, two devices of federal coordination have been initiated under the Office of Management and Budget (OMB)—one in a substate regional context under OMB Circular A-95, and the other in multi-state regions under OMB Circular A-105. The first move in this direction has evolved not out of a national interest, but out of local concern over the manner in which urban-oriented categoric programs were functioning at cross-purposes with one another. The A-95 review procedures came out of the Intergovernmental Cooperation Act of 1968, and were established to provide for a system of project notification and review through substate regional clearinghouses. While these procedures served to bring out conflicts in the effects of categoric programs in localities, they did not provide for coordination of federal programs at the national level.

A more likely source of coordination of single-purpose functions at the federal level might have come from the establishment in 1969 under OMB's Circular A-105 of ten Standard Federal Regions, each with a Federal Regional Council. However, this was and is a mechanism for the coordination of field operations of federal agencies and not a front-end effort at achieving policy coordination in the development and use of national resources.

Initiatives on Environmental Problems

In the sixties, the air, water, and the land were undergoing visible transformation. For some time scientists had warned of the effects of air pollution on human health, and smog was becoming a permanent part of the urban scene. Though Los Angeles became the national symbol of the problem, by the sixties nearly every large metropolitan area in the country was experiencing some degree of air pollution problems.

Water was also coming into the public spotlight. People were discovering that water supplies were not limitless, and water quality was not always satisfactory. They were seeing places in which they had been swimming a few years earlier being declared unsafe and banned from use. The specter of industrial and domestic waste pouring into rivers and invading lakes and coastal beaches was receiving attention in the media. In addition to serious accumulations of industrial chemical wastes in sources of drinking water, attention was turned to the effects that pesticides used in agriculture and forestry were having on water quality, fish and animal life, and the human food chain. For the first time, the consequences of adhering to a fragmented approach to resource use were becoming visible to the public at large. Also, a long established scientific maxim concerning the interconnectedness of these natural systems was beginning to receive political recognition.

In response came the National Environmental Policy Act of 1969 (NEPA), and by executive action in 1970 scattered environmental programs were consolidated into one line agency, the Environmental Protection Agency (EPA). The 1969 act, providing EPA with a guiding philosophy, stated "it is the continuing policy of

the Federal Government, in cooperation with state and local governments, and other concerned public and private organizations, to use all practical means and measures, including financial and technical assistance, in a manner calculated to foster and promote general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."

Thus, in programs relating to environmental management, a new multiple function emphasis was beginning to emerge; a clear directive was issued by Congress to bring resource use policies of the nation into harmony with environmental processes. In the same legislation, provision was made for the preparation of environmental impact statements as a condition for the funding of relevant projects from federal sources. Through this mechanism has come the necessity of opening up communications across sectoral lines.

Environmental Protection and Land Use

Standards to be met in achieving clean air and clean water were set forth in the Clean Air Act amendments of 1970 and 1977 and the Federal Water Pollution Control Act amendments of 1972 (P.L. 92-500). Although political pressures from the automotive industry have led Congress to slow down the stepwise advance in implementation of vehicular emission standards and thus the achievement of air quality goals, EPA has moved to bring "point sources" of air pollution into conformance—the smoke stack industries, chemical works, and other such activities. It has also broadened its thrust to control air pollution on other fronts, including, among other measures, an emphasis on land use planning and management—control over the location of such indirect sources as shopping centers, concentrations of employment, and recreation facilites which generate concentrations of traffic and a resultant accentuation of air pollution. Following from these activities on air quality came equally stringent moves to clean up the nation's water resources. In addition to requiring use of the best available technology in sewage disposal and industrial waste treatment systems, EPA has taken the first steps to reduce pollution and sedimentation from "nonpoint sources"—from urban runoff, construction activities, and stream channelization projects. So, in improving both water quality and air quality, land use control has become a prominent option.

Transportation accounts for one part of an interrelated urban infrastructure.

Photo courtesy of Raleigh Transit Authority, Research and Public Information Office

State Perspectives

To a significant degree, state policies and state activities in resource use management have been determined by federal perspectives and initiatives. For a period in the thirties and forties when NRPB offered grants-in-aid, states were active in making state resource surveys and state development plans. But when Congress closed down the NRPB, the funds for state resource studies dried up and state planning agencies languished. It was not until the sixties that state planning gathered a new momentum. Again federal inducements gave strength to state efforts, this time from the Department of Housing and Urban Development (HUD) through federal aid made available to states in 1968 under Section 701 of the Housing Act of 1954, as amended. Using the shared federal-state financing arrangements under this program, states reestablished planning agencies and initiated tooling-up studies and planning investigations (for example, economic growth and population studies; resource use analyses, and state development studies).

The same two developments which precipitated the beginnings of a resource conservation policy at the national level figured prominently in state actions—primarily the deterioration in environmental quality, but also to some extent some disturbing trends in the use of prized state resources. While federal inducements to states served to stimulate state action, states have entered into conservation and corrective actions not only because federal funds were available for these purposes, but also because states wished to forestall exclusive federal control over matters in which states also had interests—notably in air and water quality control and more recently in energy resource development and conservation.

The state level is closer to environmental problems and controls, and often experiences political heat on these issues. There has been a strong predisposition in some states (for example, California and Florida) to take the initiative in ameliorating the problems. These states have had higher or stricter standards and therefore wanted a position of strength in protecting their interests.

State Role in Environmental Protection

There have been state initiatives in both air and water quality which preceded programs on the national level. Although federal actions were usually more comprehensive when they eventually occurred, they benefited in many ways from earlier state experimentation. But with the enactment of NEPA, the Clean Air Act and P.L. 92-500, and the subsequent issuance of federal guidelines in which states were given a central role in administering EPA's clean air and clean water mandates, the states enacted environmental policy legisla-

tion enabling them to function as partners in environmental protection and avail themselves of responsibilities for overseeing the application of national standards within the state.

State action in resource conservation received impetus from another source—the rise of public concern in coastal states over the destructive effects to marine resources of second home and related recreation developments and the potential for damage from planned offshore oil operations. In this instance state action was facilitated by the passage of the national Coastal Zone Management Act of 1972, with its financial incentives for action by coastal states. States responded in a variety of ways. In Oregon, coastal planning and management was organized as a single program dealing with the full expanse of the coastal zone. In California, coastal reaches were divided into six regions, with land use planning and management carried out somewhat autonomously in each. In North Carolina, the individual counties were given the option to develop land use plans and manage development, with the state Coastal Resources Commission standing by to take over where counties did not exercise this prerogative.

New State Interest in Land Use Policy

Whereas state action in environmental protection and resource conservation has tended to follow federal initiatives in matters relating to land use, many states have moved ahead of national action. In part, this may be attributable to the state's primacy in local affairs. Since local units of government are created by the state and their powers thus derive from it, the states are much closer than the federal government to local concerns, among them land use. Characteristically, states release land use control powers to local units of government under home charter provisions and various enabling acts of the legislature, but usually under grants of authority carefully circumscribing the use of such powers. Land use planning and management functions have been defined with particular care because of the traditional sensitivity of constituencies to private property rights.

"Over the years, efforts to secure cross-sectoral coordination have been consistently rebuffed by various lobbies and coalitions of interest groups."

Precisely because of these conservative practices in releasing land use control powers to local units of government, state legislatures are constantly being approached by local delegations for various changes and adjustments in these powers. Legislatures have become quite conversant with land use problems as a result. Indeed, they have been "educated" to land use problems from two directions—traditionally from the bottom up, but more recently from the top down. While states have been under pressures from local officials on land use matters for some time, in the seventies for the first time pressures were coming from federal sources, for example, from EPA in the control of "nonpoint sources" of air pollution (control over the intensity of industrial, retail and recreational development which generate traffic and thus concentrations of pollutants). Obviously, problems of water quality are closely linked with land conversion practices (control of silting) and with the intensity of land use (control of urban runoff), and similarly, the intensity of development and the efficiency of layout affect rates of energy use (control of gasoline consumption).

State Role in Pass-Through Programs

The proclivity of Congress and the federal bureaucracy for insulated single-function approaches in the development of national policy has often complicated the role of the states in developing and applying land use policies. The federal guidelines in air pollution control and the incentives to states to assume responsibilities in administering national clean air standards, for example, served to create in state government a single-function approach to policy formulation. With policies and implementation standards set from above, state agencies charged with carrying out pass-through functions have little incentive or latitude to coordinate the impacts of single-function programs. As a result, the coordination function is passed on to local officials. Under the political heat generated at the local level, not only in administering the often unpopular regulations, but also in seeking some accommodation between local concerns and the sometimes conflicting requirements coming from above, there is a political feedback to state elected officials. There is thus a continuing political ferment, and, being in the middle, the states find their position extremely difficult.

"Urban officials . . . are obliged to hear the concerns of special interests from both directions."

States Assume a More Central Role in Land Use Policy

Since a number of the more critical resource use problems dealt with via the federal pass-through programs have land use impacts, the states have begun to move toward the establishment of statewide land use policies. In part this development is a reflection of an effort to bring some balance to the segmented policy situation passed down from above, but in part it is also a recognition of the need to supply a more coordinated set of guidelines for local units of government. Stimulated by these interests and by the work of the American Law Institute in the redefinition of state and local land use functions under their Model Land Development Code, several state legislatures have begun the long process of overhauling their enabling legislation. The interest in

state land use policy is also a manifestation of growing pressures from within for the state to take a more positive role in overseeing the use of resources of particular state interest, particularly in setting development standards and practices along shorelines, at scenic spots, and in areas of special interest from a historical, ecological or resource conservation standpoint. For example, in North Carolina, the Land Policy Act of 1974 provided for development and submission to the General Assembly of a statewide land classification system to promote "the orderly growth and development of the state in a manner consistent with the wise use and conservation of the land resources."

Thus, after a long period of relative inactivity, the states have become active in defining a distinctive role of their own. Indeed, the new initiatives taking place at the state level may well be the first steps toward bringing statewide resource use policies and local land use policies into a single framework. Certainly the enlarging scale of many metropolitan areas and the proliferation of local units of government found there point to the logic of the state assuming a more influential role in land use management.

The Urban Perspective

Local units of government, particularly in urban areas, contrast sharply with other governmental levels in terms of land use perspective. At the urban scale where the use of land and the complex activity systems it sustains are so markedly dependent on the smooth functioning of infrastructure (transportation, water supply, sewage disposal, power, and communications systems), there is an emphasis on the relatedness of these systems to one another and to land use. Because of the direct daily exposure to the effects when systems function at crosspurposes with one another, local officials are more attuned to the necessity of viewing the urban complex as a totality of related systems. The policies and standards contained in the various separate guidelines from above must somehow be brought into balance with local policies if the components of the total urban system are to function compatibly.

It is at the local level that resource-oriented policies from federal and state jurisdictions acquire saliency and have their workability determined. As various controls implementing these policies are put into effect, local constituencies soon grasp the costs and benefits and make their feelings known. But while urban officials are bound to recognize federal and state standards and follow guidelines as these apply in the local jurisdiction, in the course of developing land use policies for their jurisdiction they also have a primary commitment to look after the more parochial interests of residents and the local business community, and they are obliged to hear the concerns of special interest groups from both directions.

Influences from Upper Levels of Policy-Making

There are at least four conduits for sectoral policies feeding into local land use policy-making from jurisdictions up the hierarchy—(1) shortage-related resource use policies; (2) environmental protection policies; (3) housing and urban infrastructure policies; and (4) land use policies. These policies may be channeled directly from the national to the local level, or on their way down they may be augmented by state inputs. Some originate entirely from the state level. What I call "conduits" are more precisely functional groupings of land use-related policies that possess similarities in the way they affect localities. But since the transmission apparatus is typically designed to emphasize programmatic implementation of policies along vertical lines, with coordination along horizontal lines at national and state levels all but forgotten, "conduit" is an apt and descriptive term.

> ". . . land use policies provide an indirect approach to environmental protection . . ."

Not since NRPB years has there been any rigorous effort to trace out either short- or long-term substantive implications of policies of individual resource development programs across functional program areas, identify inconsistencies and conflicts, and explore alternatives for bringing policies into a compatible and coordinated framework from the vantage point of the national interest. Some observers might claim that the budget review process of OMB at the national level and budget offices at the state level provide the necessary coordination, but with a primary emphasis on budget control, these offices tend to be concerned more with cost efficiency in program performance relative to legislated objectives than with policy analysis *per se*. If these budget agencies were assigned an active policy analysis role in the pre-legislative hearing stages in policy formulation and given a policy monitoring and program coordination role in examining substantive interactions among policies and implementing systems of the programs finally authorized by legislation, not only would national and state interests be better served, but the local implementing task would be infinitely simpler. Although project notification procedures and the assembly of agency comments in the A-95 processes and in the environmental impact reviews serve to point up policy inconsistencies, the administrative effect of these field-level mechanisms is more informational than coordinative. In any case, there is no provision for coordinative action at levels from which guidelines and funding originate.

Resource Use Policies and Land Use

As we have seen, one conduit or grouping of policies from upper levels of policy-making that is beginning to have an effect on land use planning and management at the local level has to do with controls over resource use. Shortages in some kinds of resources have more land use implications at the local level than others. Some shortages will affect the makeup of a local area's economy and thus create realignments in land use patterns. The concern here is primarily with shortages

which are pervasive—energy shortages, particularly in petroleum products, and water supply shortages, to mention two very familiar examples.

We can anticipate that in the face of permanent scarcity there will be growing pressures on localities from national and state sources to include resource-demand-reducing emphases in land use policies. With respect to petroleum consumption, we can anticipate not only pressures for a shift in land transportation modes to gasoline-conserving solutions (for example, a shift in emphasis from individual private motor vehicle to mass transit systems or other shared forms of transportation), but also for structural changes in cities which may serve to reduce the length and frequencies of daily trips (for example, a change in development practices to emphasize higher density patterns, with land use distributions and mixes designed to reduce the necessity of trips). Similarly, water shortages in some parts of the country will call not only for state and, in some instances, federal action to settle on allocation policies, but in urban areas new policies in water use will become necessary. For example, dual supply systems may need to be introduced—one for drinking, kitchen, bath and laundry use; a second for yard and home systems of sewage treatment and water recirculation.

Environmental Protection Policies and Land Use

A second grouping of national and state policies channeled to local units of government which eventually exert an impact on land use policies has to do with protection of the quality of air and water and the control of noise and solid wastes. In carrying out its responsibilities to clean up the environment, EPA and its state counterpart agencies, under the pass-through features of national legislation, jointly exercise responsibilities in the administration of standards. In the large metropolitan areas, state legislation frequently enabled state EPAs to pass on implementing responsibilities to metropolitan regional agencies. Thus, this conduit feeds into local jurisdictions a multiple set of environmental protection policies from national and state agencies.

> " . . . in the long run, some more tolerable means of relating federal, state, and local interests in urban land use policy must be devised."

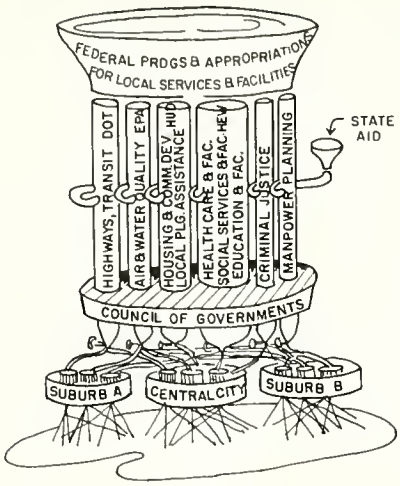
As noted earlier, land use policies provide an indirect approach to environmental protection and provide a way of alleviating the so-called "nonpoint sources" of pollution. Under this heading are the possibilities of reducing pollution levels through density and location controls, through the preservation of open space, and by bringing more attention focused on environmental protection into the design of areas undergoing development. In air quality, EPA is calling for the introduction of land development standards which control the location and limit the size and concentration of traffic-generating (thus air-polluting) land uses such as industrial centers, regional shopping centers, airports, race tracks, ballparks and other uses. Similarly, for water quality control and noise control purposes, EPA officials have been turning to land use policies and controls as one of the tools for achieving national standards.

Urban Grant-in-Aid Policies and Land Use

Still another conduit feeding into the land use policy-making task at the local level are policies that are imposed as conditions for federal and state grants-in-aid in urban programs. Over the years following the New Deal, these categoric programs multiplied; they encompassed such concerns as housing, urban renewal, sewage disposal plants, water systems, open space acquisition, highway improvements, airports, hospitals, health centers, neighborhood referral centers, and even local planning assistance. Some such programs have linkups with state counterpart agencies. For example, under federal aid highway legislation, the U.S. Department of Transportation (DOT), through partnership arrangements with state DOTs, established policies on right-of-way acquisition for urban-aid links in the Federal Primary Highway System, policies which become binding on localities if they expect to share in federal funding.

Each categoric program has had its own policy base, with a particular set of policy declarations of the Congress written into the original legislation, a set of standards, and a set of line-agency guidelines in implementation of the legislation. Where state link-up features were written into the federal legislation, there could be additional requirements added on at the state level. When the number and variety of these programs are considered, it takes no stretch of the imagination to see the plight of local officials. While the A-95 and A-105 review procedures and the NEPA environmental impact statement requirements have had the effect of informing federal and state agencies of projects being proposed for funding under categoric programs, and providing them with the opportunity to comment on conflicts or adverse effects, these provisions were not designed nor were they intended to bring the basic policies into harmony.

In the early seventies came the first structural approach to resolving the problem. This was the introduction of the revenue-sharing principle as a basic change in the approach to federal aid. The long period of study and debate in both the executive and congressional branches of government brought out two objectives of this new approach to federal aid relevant to the discussion here. Given the worsening fiscal plight of cities and the weak base of revenue support available to local units of government after the federal and state units of government had preempted the strongest sources of revenue, one key objective was to bolster the flagging fiscal situation with direct grants to be used as supplements to local general fund sources of revenues. A second objective was to abolish the proliferation of categoric programs and the confusion of uncoordinated qualifying requirements and to place the control over uses of the grants-in-aid in the hands of local governing officials.


FEDERAL PRDGS & APPROPRIATIONS FOR LOCAL SERVICES & FACILITIES
STATE AID
HIGHWAYS, TRANSIT DOT
AIR & WATER QUALITY EPA
HOUSING & COMM. DEV. LOCAL PLG. ASSISTANCE HUD
HEALTH CARE & FAC. SOCIAL SERVICES & FAC. HEW
EDUCATION & FAC.
CRIMINAL JUSTICE
MANPOWER PLANNING
COUNCIL OF GOVERNMENTS
SUBURB A
CENTRAL CITY
SUBURB B

INTERGOVERNMENTAL COOPERATION ··· PUTTING IT ALL TOGETHER
Programs and appropriations are funneled through several levels of government before they reach local communities.

Drawing by F. Stuart Chapin, Jr. and Carolyn Mosher

Congress has chosen to take a slow transitional approach to implementing the change. Apart from general revenue sharing, the first step was a consolidation of housing and community development categoric programs into block grants for a specified range of activities eligible for funding. While this step eliminates problems of policy coordination between single-function categoric programs now grouped within the community development block grant, until other categoric programs are consolidated, the cross-function policy coordination problem, though reduced, remains. And of course, as other block grant program areas are established as contemplated, the problem of coordination between the new program areas may well remain, depending upon the guidelines for submission and approval of such revenue-sharing program proposals that are developed by administering federal and state agencies.

Land Use Policies in Recent Federal-State Initiatives

The fourth conduit is directly concerned with land use policies. The recently revived state interest in land use matters is a major new source of influence being felt in local policy-making circles, but there are indications that national concerns are turning in these directions as well. The spate of activity in state legislatures during the seventies and the persistence of Congressional initiatives at the national level to provide backup to the development of state land use policies all point to the likelihood of a stronger state influence on local land use policy in the years ahead.

Some of the state initiative has been prompted by the enlarging territorial spread of urban land development patterns, a spread reaching well beyond the jurisdictional boundaries of local government. But in addition, state action is also prompted by the rapid growth in second-home and related recreational developments. At the same time states have been turning to a long-postponed overhaul of local land development powers to bring some order out of enabling legislation that has grown by accretion and tinkering over the years and to bring outmoded practices in line with new and more efficient land use management approaches. The American Law Institute's Model Land Development Code is an attempt to deal with both the state and local land use functions in one integrated piece of legislation.

The Unresolved Intergovernmental Problem

In an era of constraints, we can anticipate, then, that there will be increasing rather than reduced pressures of all kinds on local units of government, and we can anticipate that the layering of policies channeled down from above will create continuing tension in the merging of new with established land use policies. These tensions will mount not so much from any disagreement over the merits of the objectives as from the segmented way in which policies converge on localities, leaving to local units of government the very onerous task of reconciling cross-sectoral effects and conflicts. The task will be particularly difficult because local governments already have many critical concerns in harmonizing and making the infrastructure and land development systems of the urban area function as a coordinated and smoothly functioning whole. And of course the whole process is complicated by the substantial federal aid that usually accompanies sectoral programs in comparison to the relatively meager resources available to localities to work out these accommodations.

Although local planning and decisionmaking officials will need to adjust to these realities in the short run, in the long term some more tolerable means of relating federal, state, and local interests in urban land use policy must be devised. In the light of the experience in intergovernmental relations to date, it would appear that any long-term solution should seek to (1) reduce the number of sectors requiring intersectoral coordination, (2) improve the means of coordination between sectors, and (3) minimize intrusion on legislative control over resource allocation. At least two actions appear to merit consideration. One is an extension of the block grant mechanism to embrace more sectoral programs. This would serve to reduce the number of sectors requiring coordination at the national level, improve the opportunities for coordination at the local level, and further limit the number of programs where political conflict could arise in the resource allocation process. A complementing action would be the assignment of a stronger policy coordinating role to OMB, assigning it policy coordinating responsibilities for the Executive Office in the prelegislative stage in the development of national policy affecting land use and giving it an A-95 clearinghouse role at the national level in the coordination of sectoral policies that affect localities. The first action would require legislation, and the second would seem to be a prerogative open to the president. Local units of government should press for changes of these kinds.

Glenn Harbeck

Growth Management for Barrier Island Communities: A Comparative Evaluation

In the last fifteen to twenty years the people of the United States have been attracted to the nation's ocean beaches in greatly increasing numbers. The areas of heaviest use have been wherever good roads lead from the growing coastal plain urban centers to "unspoiled" shores. For many years, the chain of barrier islands along the country's southeastern margins were exempted from this cavalcade of beach-goers, largely due to a general lack of good automobile access. With an ever-increasing demand for more beaches, however, came a public demand for improved accessibility to the barrier islands. The response of state governments was the establishment of ferries or the construction of bridges and causeways.

Improved access, in turn, caused a rapid influx of visitors and tourists to the barrier islands. Among these visitors were permanent and second home seekers and resort developers. Soon after the resultant rise in ocean-oriented development came the realization that the old bridges and infrequent ferry services would no longer be adequate. Old bridges were enlarged or new bridges were built, and more ferries with greater capacities ran more often. This vicious circle between accessibility and development grew, picking up speed and momentum, consuming more barrier island land at faster rates. There seemed few deterrents to the cycle as long as the demand continued and there were land owners willing to sell.

Toward the end of the 1960s, however, many of the good building sites, those on relatively high land and in protected locations, were taken. A new breed of coastal dwellers was buying the remaining lots by the early 1970s. Farmers from the Midwest, businessmen from the Northeast, and the retired built or bought homes on land raised from the "leftover" marshes. A little ingenuity and a greater use of the new dredge-fill and bulldozing "technology" provided the means.

The effects of rapid, unplanned development on extensive filled land and other poor sites soon became evident. Dying shellfish beds, eroding beaches, and salt-water intrusion in ground waters were a few of the indications. It was not long, however, before these changes struck home—in property owners' bank accounts. *Ad valorem* taxes began to reflect the costs of new or expanded sewage treatment facilities, municipal water supply systems, and shore erosion protection projects. Under these mounting tax pressures island residents began to question what the future course of ocean-oriented development should be.

This article examines two barrier island communities of the southeastern United States experiencing similar development pressures but employing contrasting local management strategies for controlling growth. The formulation of the ecologically supported carrying capacity plan of the city of Sanibel, Florida, is compared to the more traditional land use plan development approach taken by the town of Wrightsville Beach, North Carolina. Each municipality's plan implementation and regulatory mechanisms are then evaluated on their ability to translate the objectives set forth in their land use plans into reality on the ground. In doing so, consideration is given to the manpower and funding levels of each community's technical consultants, the local political climate within which each plan was developed, and the arena of state enabling legislation within which each plan performs.

Overview of the Two Programs

Wrightsville Beach, North Carolina has accumulated a development control "system" over the years in piecemeal fashion, having adopted one ordinance and then another as necessary, without the general guidance of a comprehensive plan. In 1976, the town adopted its first land use plan to meet requirements of the state's Coastal Area Management Act of 1974. The

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document, however, has had only limited impact on the content and functioning of the town's development controls. These mechanisms continue to operate independently of the land use plan. Even so, Wrightsville Beach has had a tradition of keeping one step ahead of most ocean-oriented communities in North Carolina, and is considered to possess one of the better local systems on the coast for regulating development.[1] The Beach's planning effort is an example of how a loosely organized set of development ordinances and an "after the fact" land use plan can work their way into the local political framework and be effective, given the right local administrative and political leadership. However, given the wrong leadership—leadership less familiar with the development system or with the political fabric—the same regulatory structure may collapse entirely.

Sanibel Island, Florida, incorporated as a city in 1974 to rid itself of the large future population levels allocated to it by county zoning. In 1976, a carrying capacity-based *Comprehensive Land Use Plan* was adopted as a city ordinance with all development regulations, performance standards, and administrative procedures firmly attached—physically and functionally. Sanibel's aggressive growth management program, which reduced the allowable number of dwellings on the island from 30,000 to 7,800 (Clark 1976, pp. 86, 90), has received considerable attention from planners and the lawyers of developers alike. The city's pioneering strides in planning development according to the carrying capacity of natural systems opens new roads for the planning efforts of other communities with fragile ecosystems.

Sanibel Island Development History

The earlier general discussion, in many respects, closely parallels the historical pattern of development on Sanibel Island, Florida (Clark 1976, pp. 6-7, 12-15). The barrier island supported a small farming population until a severe hurricane struck the island in 1926, causing salt-water inundation and ruining the agricultural industry. Residents who remained after the flood turned to serving the modest winter visitor population. The number of seasonal visitors increased very little from 1927 to the mid 1940s while the year round population held steady at about one hundred. The 1950s witnessed a gradual rise in the island's tourist trade and an accompanying increase in residential development.

The construction of a causeway to the mainland in 1963, however, resulted in an unprecedented surge in the growth rate. A ten-year development boom followed, placing dwellings in parts of the island that had been considered unsuitable for development in previous years. Septic systems became widespread, seriously degrading surface waters. Increasing demands on the island ground water supply made salt-water intrusion of the freshwater aquifer a major concern. By the 1974 peak tourist season, the island had grown to 12,000 residents and over 4,000 housing units.

Additionally, there appeared to be little relief in sight. Lee County zoning, under whose jurisdiction Sanibel Island fell, authorized permits for a potential additional growth of 26,000 dwelling units. As long as the island remained unincorporated, the residents had no real powers to combat the island's unattractive development

The strains from development on Wrightsville Beach's water and sewage system prompted a down-zoning of the community.

Photo by Glenn Harbeck

future. In view of this, the people of Sanibel Island in 1974 stated:

> [We, in] desiring to have the rights of self determination, to the fullest extent allowed by law, in the planning for the orderly future development of an island community known far and wide for its unique atmosphere and unusual natural environment, and to insure compliance with such planning so that these unique and natural characteristics of the island shall be preserved, do seek the benefits conferred on municipal corporations by the Constitution and the laws of the State of Florida. (City of Sanibel 1974)

Within one month's time after incorporation, a city council and mayor were elected by Sanibel voters, and a moratorium on all new building permits was instituted. Work began on the selection of a planning consultant suitable to the island's needs. In April 1975, the firm of Wallace, McHarg, Roberts, and Todd (WMRT) was contracted and the community set about preparing its first comprehensive land use plan.

Formulation of the Plan

When examining a local planning effort for evaluation or comparison with other local efforts, it is only logical that consideration be given to any operational factors that may contribute substantially to the success or failure of the process. In the case of Sanibel Island, three such factors are involved: (1) the manpower and technical expertise of the planning consultant, (2) the level of funding available to the consultant for primary and supporting studies, and (3) the prevailing attitude of island residents about the need for planning.

It is customary and often anticipated that a small community will select a planning consultant from among those operating in the general region within which the town is located. Sanibel Island, however, selected the Philadelphia-based, nationally known firm of Wallace, McHarg, Roberts, and Todd as planning consultants. WMRT, in turn, subcontracted legal, utility, and traffic technical assistance from other consultants (Clark 1976, p. 85). Additionally, WMRT was aided by the scientific expertise of the Sanibel-Captiva Conservation Foundation. A staff of eighteen Conservation Foundation scientists, assisted by a panel of special technical advisors, conducted natural system studies of the island (Clark 1976, p. 19). The results were then used to formulate and substantiate the development control policies and growth limitations of the land use plan.

The foundation provided its services at no cost to the city, having secured funding through private and charitable donations (Clark 1976, p. 15). In general, the predominantly affluent island community had relatively few difficulties financing the planning process.

The whole question of incorporation for Sanibel centered around the issue of whether planning guidance and development regulation should remain the responsibility of the county or be given to a local authority. The 1974 island decision in favor of incorporation was essentially a vote for the latter. The idea of local planning for Sanibel Island was a local initiative. It was not mandated by any federal, state, or regional authority.[2] To some extent, therefore, the planning program had the support of the local constituency from the start. The establishment of citizen task forces and the procurement of public input to the planning process were made that much easier.

Wallace, McHarg, Roberts, and Todd were aware they were selected as planning consultants to achieve one overall objective: to devise a land use plan and supporting regulations that would substantially curb growth on Sanibel Island. To reach this end, a number of questions needed answers. First and foremost, what means and avenues legally justify the denial of future growth? More specifically, in terms of the island's natural carrying capacity—what criteria determine threshold population levels for the island? Finally, how can growth limitations be related to the health, safety, and welfare of island residents?

Finding the answers to these questions required three major phases of development. First, the planners needed to define the ecosystem of Sanibel Island with all its biological and physical intricacies and apply these concepts to appropriate geographic portions of the island. Second, the ecological carrying capacity of each geographic zone had to be defined according to the relative tolerance of the area to various residential and commercial development densities. The derivation of these limits was bound firmly to the natural studies of phase one. Total growth levels were then modified by the city's estimated fiscal ability and legally justified by public health, safety, and welfare factors (hurricane evacuation, fire protection, etc.). Third, and finally, the plan would require performance standards, development regulations, and administrative procedures to insure that the growth limitations would not be exceeded.

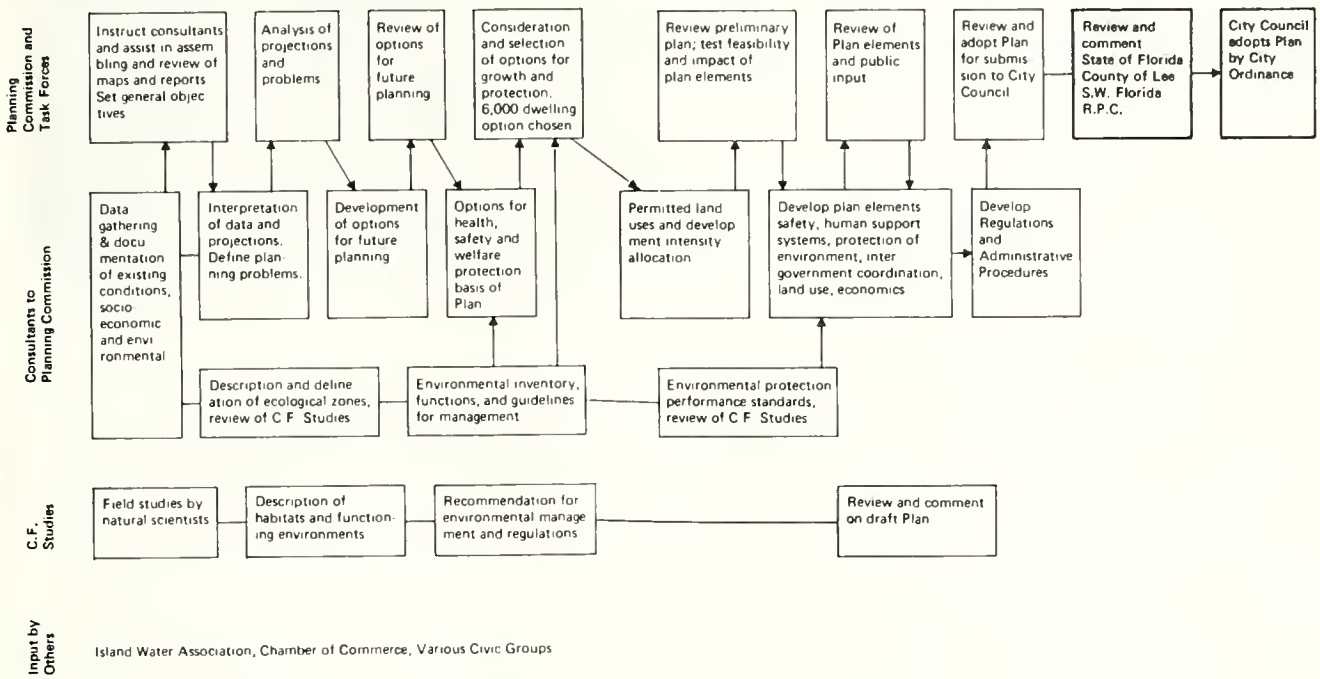
> ". . .the people of the town were not behind the planning process and its purpose as much as the CAMA's authors originally intended."

This had to be done in a manner that would not blatantly overstep its constitutional powers, thus encouraging a number of potential lawsuits from land owners and developers.

For the first phase, WMRT relied on the Conservation Foundation to identify natural systems and ecological zones of the island. The natural studies information was then considered in conjunction with traditional socio-economic and population studies. Various alternative population ceilings were formulated and presented to the planning commission, citizen task forces, and island residents for a weighting against the city's ability to provide services, and to maintain the island's lifestyle. The alternative eventually selected by the commission projected a city population growth limit of 6,000 dwelling units. This number was only 2,000 units more than 1975 existing figures of 4,000 (Clark 1976, pp. 86-90).

Figure 1

The Sanibel Planning Process


Planning Commission and Task Forces
Instruct consultants and assist in assembling and review of maps and reports Set general objectives
Analysis of projections and problems
Review of options for future planning
Consideration and selection of options for growth and protection. 6,000 dwelling option chosen
Review preliminary plan; test feasibility and impact of plan elements
Review of Plan elements and public input
Review and adopt Plan for submission to City Council
Review and comment State of Florida County of Lee S.W. Florida R.P.C.
City Council adopts Plan by City Ordinance
Consultants to Planning Commission
Data gathering & documentation of existing conditions, socio economic and environmental
Interpretation of data and projections. Define planning problems.
Development of options for future planning
Options for health, safety and welfare protection basis of Plan
Permitted land uses and development intensity allocation
Develop plan elements safety, human support systems, protection of environment, inter government coordination, land use, economics
Develop Regulations and Administrative Procedures
Description and delineation of ecological zones, review of C F Studies
Environmental inventory, functions, and guidelines for management
Environmental protection performance standards, review of C F Studies
C.F. Studies
Field studies by natural scientists
Description of habitats and functioning environments
Recommendation for environmental management and regulations
Review and comment on draft Plan
Input by Others
Island Water Association, Chamber of Commerce, Various Civic Groups

Source: The Conservation Foundation

These 2,000 additional future units were then distributed among the ecological zones according to the relative tolerance of each zone to development. Also given weight were practical considerations such as proximity of the site to sewers and the status of improvements to the land.

Public hearings were held, compromises made, and public support gained. Performance standards were developed for each ecological zone and administrative procedures were drafted for a development permit process and for amendments to the plan. Before the final version was prepared and adopted, state, regional, and local authorities received copies of the preliminary plan for review and comment. Figure 1 describes the entire plan formulation process.

Sanibel Plan Implementation

In general, plan implementation requires the selection of a particular combination of administrative tools to guide development so that what evolves on the ground follows plan objectives as closely as possible. Some commonly recognized actions available for implementation include: budgeting and investment for capital improvements, the planned provision of public services, the adoption of regulatory ordinances and codes, the use of coordinated administrative procedures, and education of the public as to the purpose and objectives of the plan.

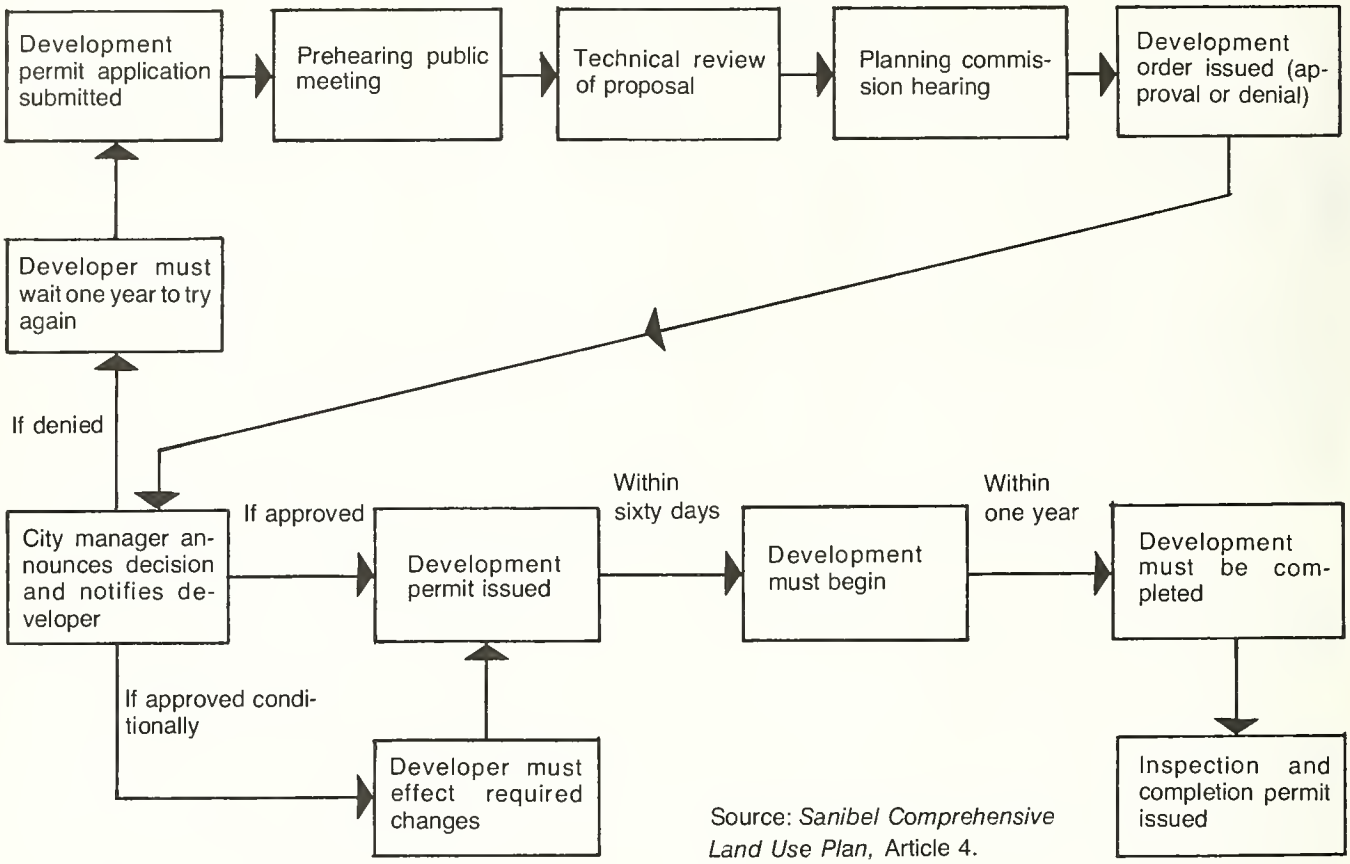
For the majority of towns and counties, regulatory aspects of plan implementation have been drawn up, adopted, maintained, and enforced in documents separate from the land use plan. In many cases, as will be discussed in the Wrightsville Beach example, these tools for implementation have actually been instituted prior to the writing of the land use plan. In essence, they have together constituted town development policies.

The authors of the Sanibel plan, however, made use of provisions in Florida's Local Government Comprehensive Planning Act of 1975. The act changed the role of a land use plan from primarily advisory in nature to a document with legal status (City of Sanibel 1976). For example, Sanibel plan regulations that normally would have appeared as individual city codes or ordinances such as zoning and subdivision regulations, are compiled into a single development regulations section within the plan. Also, particular regulations are referenced to the human support systems, land use, or other sections of the plan for documentation and clarification. Such references strengthen the bond between the plan and its implementation measures.

In the area of capital improvements and municipal services provision, investments are geared to the growth ceiling imposed by the plan. Equally important is that the plan proposes only those investments that are within a financially feasible range for the city. Following each discussion of an existing or proposed community facility or service, necessary improvements and associated costs are itemized. Using this format, a citizen reading the plan clearly sees: (1) the existing situation,

Figure 2

Sanibel Development Permit Process


Development permit application submitted
Prehearing public meeting
Technical review of proposal
Planning commission hearing
Development order issued (approval or denial)
Developer must wait one year to try again
If denied
City manager announces decision and notifies developer
If approved
Development permit issued
Within sixty days
Development must begin
Within one year
Development must be completed
Inspection and completion permit issued
If approved conditionally
Developer must effect required changes

Source: *Sanibel Comprehensive Land Use Plan,* Article 4.

(2) deficiencies in facilities and services, (3) the actions needed to correct the deficiencies, and (4) the specific costs involved. Also, because the plan will be updated every five years, capital improvements and services provisions will be revised to reflect changes in the land use plan and its policies.

The last general implementation mechanism, the administrative coordination function, is addressed under the administrative regulations section of the plan. This section recognizes that regulations are of little value unless new development proposals are reviewed on a consistent, methodical, clearly articulated basis. The Sanibel plan's development permit process provides such a basis. The process is summarized in Figure 2.

There are several characteristics of the process that warrant mention. First, the procedure is one-directional and is composed of a series of well defined steps. The developer can find exactly what he or she faces in the permitting process and can prepare the development proposal accordingly. Second, since time limitations are specified for each step of the process, the decision maker, developer, citizen, or other interested party has a clear picture of the time frame involved. Third, there are two regularly scheduled opportunities for public participation in the early going, the first being the prehearing public meeting and the second being the mandatory hearing before the planning commission. This is important in keeping the public abreast of the planning process and of development trends in the community. Fourth, under the Sanibel permit process, the city council is not directly involved in the decision making. City council members may voice opinions at either of the two public meetings in the same manner as any other citizen. It is the planning commission that has the authority to approve or deny the development application. This is a clear separation of powers and responsibilities between the two decision-making bodies and is intended to make the permit process more streamlined.

Wrightsville Beach Development History

In 1974, while Sanibel Island was undergoing incorporation procedures, Wrightsville Beach, North Carolina was having development problems of its own. Before discussing the near-crisis situation that the town faced in that year, the historical pattern of development that led to the community's difficulties is examined (Town of Wrightsville Beach 1970, pp. 3-4).

Wrightsville Beach is a relatively old resort town on the North Carolina coast, having incorporated in 1899. The community was attracting visitors long before the beach boom of the 1960s and 70s. In the early 1900s, for example, trolleys ran regularly from the nearby city of Wilmington and in the 1930s, dancing at the Lumina Pavilion was the beach's calling card.

Development progressed at a steady but unimpressive rate until the mid-1950s when several hurricanes struck the town in close succession, causing severe

Sanibel, Florida has adopted a plan which is based on the carrying capacity of the island. Photo by John Clark, The Conservation Foundation

damage to beach properties and discouraging reconstruction efforts. The relatively storm-free period of the 1960s, accompanied by increased ocean-front development pressures and spillover from the expanding Wilmington urban area, gave new impetus to growth at Wrightsville Beach.

In response to the immediate and potential effects of this development trend, the town adopted a zoning ordinance, and later, subdivision regulations were passed. Development pressures peaked during a construction boom from 1970 to 1973. The town board of aldermen became particularly critical of the intensity of land use brought about by several high-rise developments. More and more people were becoming concentrated on the two small islands that make up Wrightsville Beach. Additionally, there was much concern about whether the town's ground water supplies could keep up with the heavy usage demands of peak summer weekends. Though not considered dangerous to health, the sulfur content of the community's well water system was becoming noticeably high during the latter summer months. The capacity and capability of the town's sewage treatment plant also became questionable. At least one resident, claiming that the sewage treatment facility was inadequate, took the town to court over the issue.

The board was ultimately forced into making a politically delicate move. In 1974, after several heated, highly controversial public hearings, the board of aldermen authorized a down-zoning of the entire community. This meant, for instance, that wherever duplexes had been permitted under previous zoning, now only single family residences would be allowed. Also, no new commercial zones were to be created. After the decision, the town committed itself to a policy of constantly reducing its development density—or as more properly stated in the town's land use plan: "To maintain and enhance Wrightsville Beach as a predominantly low to moderate density single family residential community" (Town of Wrightsville Beach 1976, p. 22).

One of the results of this policy is that whenever a zoning change is requested that would effect a down-zoning of the property involved, an approval is likely. Conversely, rezoning requests that would increase the allowable intensity of use are viewed very critically by the town board. Additionally, town officials attempt to discourage this rezoning by pointing out the substantially higher sewage treatment and fire protection building costs incurred by the prospective rebuilder contemplating higher intensity development. Finally, at a time when the typical North Carolina ocean-front lot has a fifty foot frontage and a 5,000 square foot area, Wrightsville Beach zoning stipulates that any new development must have a minimum seventy foot frontage and at least 8,000 square feet of area.

All the above were done without the general guidance of a comprehensive plan. The next section will examine how the town's 1976 plan has affected the content and operation of local regulatory tools.

Formulation of the Plan

In 1974, the North Carolina General Assembly passed the controversial, heavily amended Coastal Area Management Act (CAMA). CAMA mandated that all local governments within the state's twenty county coastal area prepare (or have prepared for them) land use plans. The act stated that each plan shall "consist of statements of objectives, policies and standards to be followed in the public and private use of the land" (N.C. CAMA 1974). Wrightsville Beach was one of the fifty-three cities and counties that fell under the provisions of CAMA. Unlike many other municipalities on the coast at that time, Wrightsville Beach had already adopted and was enforcing its own set of development regulations.

The immediate reaction of the town to CAMA was that the land use plan requirement was both unnecessary and an infringement of home rule powers. As it was later revealed, much of this attitude was due to a general misunderstanding of what CAMA was actually going to do. When local officials realized that CAMA would not fundamentally change their existing development

"...Wrightsville Beach ordinances tend to be more stringent and more strongly enforced than their CAMA counterparts."

policies and procedures, they essentially said: "Fine, let's fulfill the requirements and be done with it." Additionally, town decision-makers recognized that by doing so, extra money would be brought to the community for plan implementation and enforcement machinery that was already in operation. Thus, from the start, Wrightsville Beach did not visualize the land use plan as a tool for growth management but rather as an unavoidable duty.

The technical consultant for the plan was the North Carolina State Department of Natural and Economic Resources, Local Planning and Management Services Section of Wilmington field office. The project staff consisted of one planner and two planning technicians. While funding provisions were sufficient for all phases of the planning process as prescribed by CAMA

guidelines, they did not allow for any special frills (scientific studies, special consultants, etc. as in Sanibel).[3]

Indicative of the problems the planners faced was the local response to the call for public participation. An important aspect of CAMA was its emphasis on and requirement for public participation in plan development. At Wrightsville Beach, much of this citizen input had to be sought after from citizen groups and service clubs. The people of the town were not behind the planning process and its purpose as much as CAMA's authors originally intended.

At this time state water quality officials were criticizing the town's municipal sewage treatment plant, a plant that Wrightsville Beach had built with local money in the 1940s. Other communities on the coast in the 1940s were fortunate if they had homes with properly functioning septic systems. This only served to further aggravate resentment of state interference in "local" matters.

In view of the considerations just described, the nature and purpose of CAMA, and the mature stage of development at the beach, the state planning consultant saw the purpose of the land use planning process lying in three areas (Hooton 1977):

(1) To provide a good planning data base for more informed local decision-making

(2) To resolve conflicts that had developed between the planning board and the board of aldermen and to rejuvenate the stagnating planning process

(3) To solve the central issue of public access to "private" beach areas.(The increasing occurrence of "outsiders, tourists, hippies and beach bums" walking across private properties had angered many residents.)

Before the actual plan formulation could begin, the state consultant had to gain the confidence of the planning board and town aldermen while promoting a cooperative spirit between the two bodies. Three months of groundwork was necessary. The planner attempted to disassociate himself from other state agencies that were viewed negatively by town decision-makers. Any qualms that the decision makers may have had about the impact of CAMA on the town's existing operations and physical development policies were played down by the planner.

During this time the consultant also began collecting data sources and started identifying what he thought were the town's general problems and issues. After grasping a preliminary sense for concerns that town residents might have, the planner distributed a survey which asked for comments on the problems he had identified. Simultaneous meetings with community groups served a similar function. Results of the survey were given to the planning board members who were asked to assign relative priorities to these town concerns.

From the survey community meetings, and the planning board priority ssignments, the planning consultant was able to form ate general objectives and policies. Little emphasis, however, was placed on standards. Rather, they were adopted by reference to other town ordinances and regulatory mechanisms. This was due in part to the then unidentified areas of environmental concern (AECs) within the town. Had AECs been designated at that time, new CAMA standards would have been applicable.

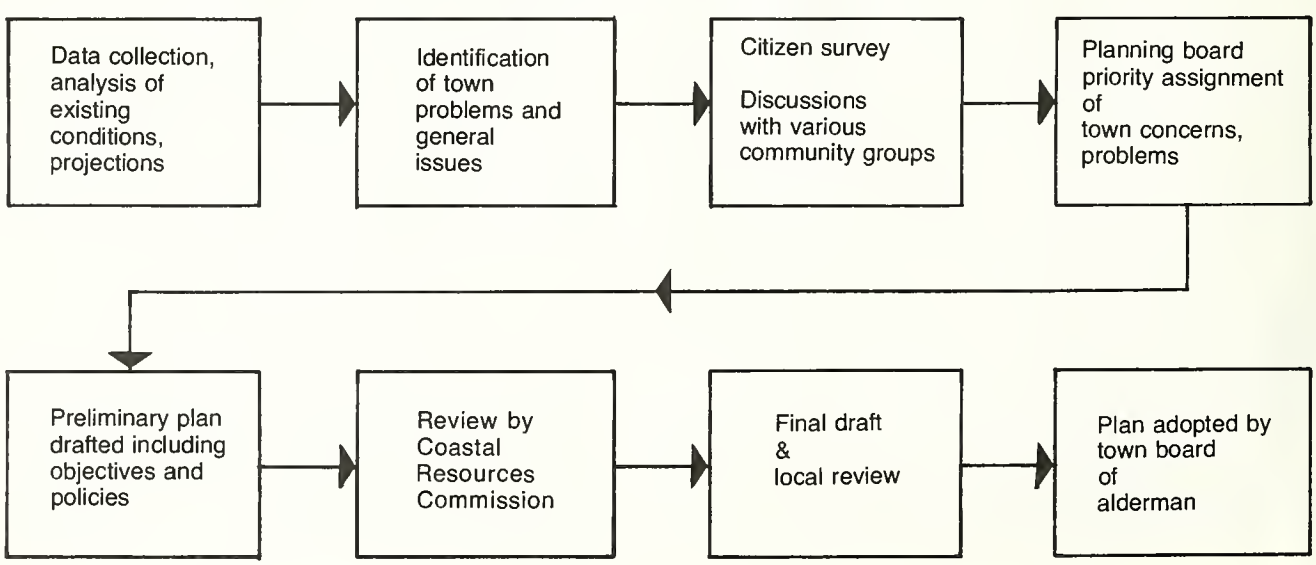
A completed preliminary plan was sent to the state's Coastal Resources Commission for review and comment for consistency with CAMA guidelines. The last version of the plan was then prepared for final review and adoption by the town board. The entire plan formulation process is summarized in Figure 3.

Wrightsville Beach Plan Implementation

In examining Wrightsville Beach's plan implementation provisions, the following avenues for public action

Figure 3

Wrightsville Beach Plan Formulation


Data collection, analysis of existing conditions, projections
Identification of town problems and general issues
Citizen survey
Discussions with various community groups
Planning board priority assignment of town concerns, problems
Preliminary plan drafted including objectives and policies
Review by Coastal Resources Commission
Final draft & local review
Plan adopted by town board of alderman

are reconsidered: the planned provision of capital improvements and public services, the adoption of regulatory ordinances and codes, the use of coordinated administrative procedures, and education of the public as to the purpose and objectives of the plan.

Wrightsville Beach has traditionally geared its public services and capital improvements to meeting rather than controlling development pressures. The general policy has been that municipal facilities are planned and built to accommodate population increases rather than as tools to influence development. For example, the land use plan states: "The major facilities that are presently reaching capacity are water, sewer, and solid waste and each is being planned for modification or expansion as future demands require" (Town of Wrightsville Beach 1976, p. 36). Any notion of permanently denying development on a feasibly buildable tract of land within the town would not generally be entertained by local decision-makers.

"Through the use of a "flexible" permitting procedure and development review process, the town has been able to control development with some success."

After adoption of the land use plan, CAMA required local governments to review zoning, subdivision, and other regulatory standards for consistency with the plan. CAMA guidelines, and consequently the local land use plan, offer no specific mechanisms or procedures for reviewing and, if necessary, revising ordinances and codes.[4] Once the plan is adopted and turned over to the town for implementation, the planner has little say over the way in which it is used (or not used). Thus the plan may be considered only slightly better than advisory in nature rather than authoritative.

Since town policies over the years have been embodied in the town's ordinances, and since the same policies are restated (though more concisely) in the land use plan, it became apparent that little change in the town ordinances would be necessary following plan adoption. This is exactly what occurred. The various parts of the town code were examined for consistency in more or less obligatory fashion with the result that no changes were recommended by CRC (Nesbitt 1977).

A final reason for the limited review is that Wrightsville Beach ordinances tend to be more stringent and more strongly enforced than their CAMA counterparts. One possible explanation of this is that most of the CAMA requirements were written to insure that many coastal communities without any existing regulations or controls would have at least basic tools available.

In terms of educating the public as to the purpose and objectives of the plan, there appears to be no continuing mechanism operating for this purpose at Wrightsville Beach. An important requirement of CAMA, however, was the writing of a synopsis of the local land use plan for distribution to town residents. Unfortunately, public response to the synopses has been much less than hoped for.

If the town has managed for so long without the guidance of a comprehensive plan and since these mechanisms continue to operate independently of the land use plan, what then is the town's central guidance system? The answer lies in the final implementation consideration, that of administrative coordination. Through the use of a flexible permitting procedure and development review process, the town has been able to control development with some success. This process is illustrated in Figure 4.

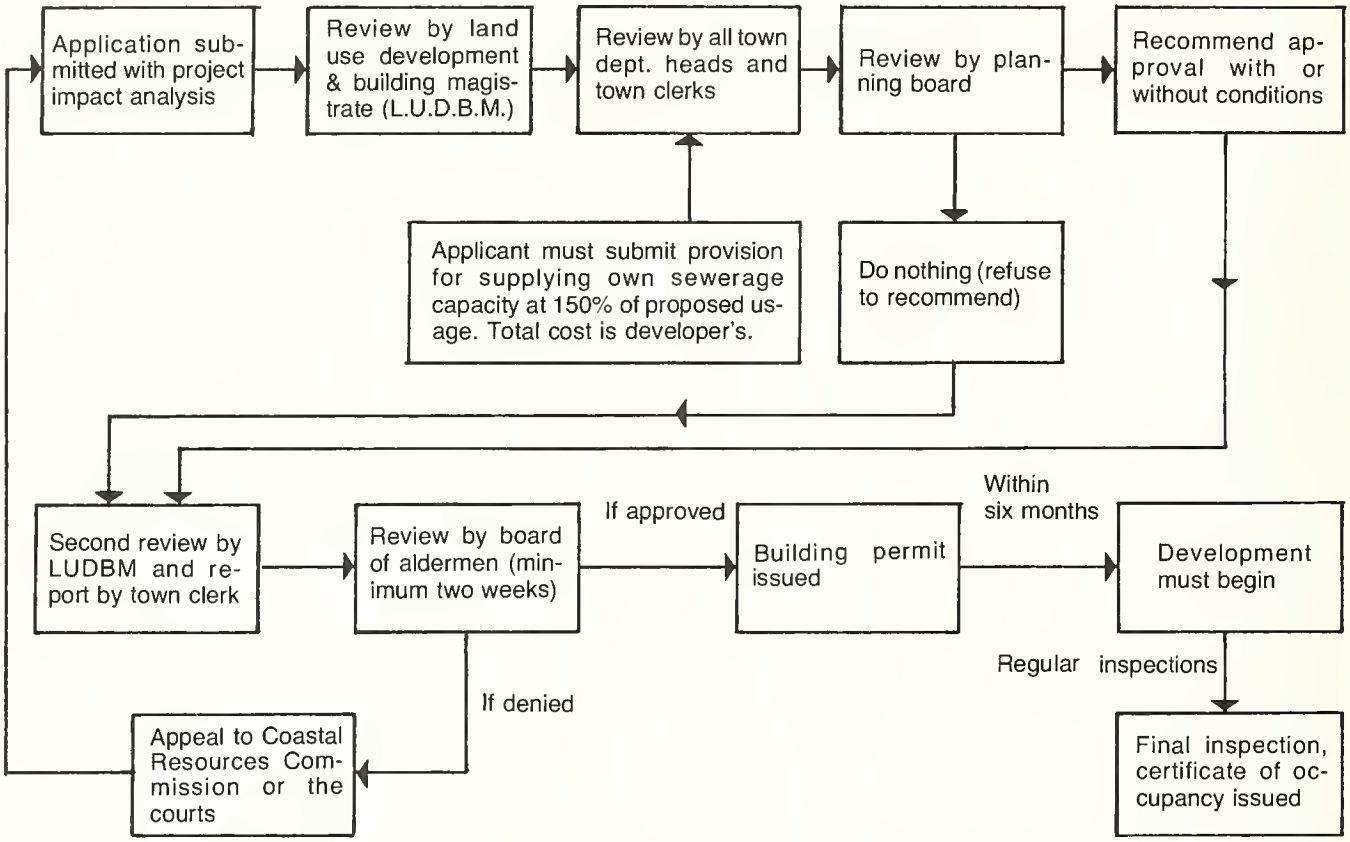
At first glance, the town's permit system appears to be as complete and clearly articulated as the Sanibel process. There is, however, a significant difference in the sources of information used for the construction of these diagrams. The Sanibel permit process flow chart, as illustrated earlier in this article, was constructed directly from written provisions in the Sanibel Plan. The Wrightsville Beach process, as formulated here, is found in no single public document and was derived for the most part from a lengthy interview with the Wrightsville Beach Land Use, Development, and Building Director (hereafter called the director) (Nesbitt 1977). While the Sanibel process is spelled out for the developer, decision-maker, or interested citizen, the Wrightsville Beach procedure is known only to those town officials who have dealt with it over some period of time.

When a developer wishes to engage in construction of any kind within Wrightsville Beach, he must first notify the director. The director is both the initial and continuing contact for the developer. Thus, much discretion in the guidance of the town's development policies is left to the director. Someday, a new director will replace the present one. To insure similar enforcement of the town's regulations, the new director will need clear directives, standards, and policy statements on which to base his or her decisions.

In recent years, the less than well understood permit process may have worked to the advantage of the town. The existing process's screen of unclarity may have served to disguise the town's possible motives behind additional delays imposed on the developer. It has also allowed the director to interpret ordinances in the manner that he feels is most advantageous to the town's growth policy. The planning board and town aldermen (who also serve as the board of adjustment) could conveniently support his decisions. In this manner, the town could be playing a sensitive game with some developers— a game in which the town's strategy is to keep one step away from potential lawsuits. Clearly, if Wrightsville Beach were less built up, if the development pattern were less clearly defined, and if more vacant land were available, court challenges could be expected under the existing framework.

One way in which Wrightsville Beach has tried to insure that any new development will not significantly impair the town's facilities and services is through a requirement for a project impact analysis. This questionnaire-type form must be completed by any "developer who proposes to construct a building or housing

Figure 4
Wrightsville Beach Permit Process


Application submitted with project impact analysis
Review by land use development & building magistrate (L.U.D.B.M.)
Review by all town dept. heads and town clerks
Review by planning board
Recommend approval with or without conditions
Applicant must submit provision for supplying own sewerage capacity at 150% of proposed usage. Total cost is developer's.
Do nothing (refuse to recommend)
Second review by LUDBM and report by town clerk
Review by board of aldermen (minimum two weeks)
If approved
Building permit issued
Within six months
Development must begin
Regular inspections
Final inspection, certificate of occupancy issued
If denied
Appeal to Coastal Resources Commission or the courts

group containing more than two (2) dwelling units, or a commercial establishment requiring a water tap greater than 2 inches or where parking shall exceed 20 cars" (Town of Wrightsville Beach 1974). As shown in Figure 4, this is generally submitted with the building permit application. The form is useful because it places the initial task of information gathering for impact analysis on the developer rather than on the municipality. The developer must provide specified information about the impact of the proposal on all of the town's facilities and services (including estimated sewage flows, water requirements, solid waste loads, etc.) and provide calculations.

After consultation with all town department heads, the town clerk assesses the potential impacts of the project on each of the community's resources. The evaluation concludes with the estimated annual income to the town from the project and estimated annual costs. The results of the analysis, along with any additional comments by department heads, are then submitted to the board of aldermen for their review and approval or denial of the project.

An apparent fault of the impact analysis format (as outlined on the first page of the questionnaire) is that it makes no allowance for review and comment by the town's planning board. This may be merely an oversight by the author(s) or it may be an intentional slighting of the planning board. In either case it seems that, although the planning board has no powers for project denial, its comments should be officially requested in the form.

State Enabling Legislation

Evaluation of the Sanibel and Wrightsville Beach growth management programs thus far has been based on the individual and isolated efforts of each community. It is important to examine the state enabling legislation under which each plan and plan implementation provisions were developed.

The comprehensive plan of the city of Sanibel was formulated according to guidelines put forth in Florida's Local Government Planning Act of 1975. Commenting on the act, Alexander *et al.* at the University of Florida have noted:

> The fundamental change that the [Local Government Planning] Act produces is that the comprehensive plan becomes a binding legal document (Section 12, Subsection 1). For the first time on a statewide basis throughout Florida, once a plan has been adopted, all actions taken in regard to regulation of land development by local governments must be consistent with the adopted plan. The day is gone when conceptual plans sit on the shelf as land development occurs in its own haphazard, piecemeal fashion. (1975, p. 21)

Alexander *et al.* also observe: "Any new public or private development must be in conformity with the

adopted comprehensive plan *or the plan must be amended* to accommodate such development" (emphasis added) (1975, p. 8).

Florida's coastal management program, as well as the coastal programs of several other states, was developed using the 1975 *Model Land Development Code* by the American Law Institute as a basis. The code describes how a well-equipped local growth management tool box should be stocked and how these tools might be used best.

"...given the status of North Carolina's enabling legislation, and the degree of development pressure on Wrightsville Beach, the town's regulatory controls are commendable."

North Carolina's statutes addressing development regulations and planning for municipalities and counties are based on planning techniques that were in accepted use in the 1930s, and are now becoming antiquated. Wrightsville Beach's system of development controls has evolved following the pattern of the old state-promulgated concepts. Under North Carolina law, implementation of the land use plan is left entirely in the hands of local government:

> It is imperative for each involved agency of local government to devise the most practical and applicable methods for insuring that the (land use plan) will be implemented and not shelved. (Coastal Resources Commission 1975, p. 23)

It is probably appropriate to state that, given the status of North Carolina's enabling legislation, and the degree of development pressure on Wrightsville Beach, the town's regulatory controls are commendable. Despite strong pressures for commercial development and more intensive land uses, Wrightsville Beach residents have managed to maintain their community as a predominantly single family, resort town. In view of the heavily amended, watered-down version of the original CAMA legislation, and the late, frequently unclear guidelines of the act, the Beach's land use plan is probably as well formulated as any on the North Carolina coast.

If the burden for better growth management is to be placed on any government body, it is the North Carolina General Assembly (See the recent N.C. House Joint Resolution DRHJR1079 which proposes a study of the possibility of state adoption of the ALI Code.). Since CAMA has resulted in so many new land use plans for coastal cities and counties, many of which had had no previous planning experience, it is unfortunate that they were not given the option of following the ALI model.

Conclusions

Until such a time as the North Carolina legislators decide that the state's planning and development regulation statutes need updating, the town of Wrightsville Beach could improve its overall growth management effort by adopting the following recommendations:

(1) A clear linkage (in writing) should be established between zoning, subdivision regulations, other applicable parts of the town code, and the 1976 land use plan. While these regulations have been reviewed for consistency with the plan, they make no reference to it and should do so. For the present time, an introductory clause at the beginning of each ordinance drawing attention to the broader town policies and objectives of the land use plan would be satisfactory.

(2) A list of development ordinances, permits, and fees which the town enforces should be compiled in a single document. For development types where state or federal permits are also typically required, appropriate notation might be included.

(3) A checklist of general requirements with which developers must comply should be devised. The same checklist may serve as evaluation criteria for review of development proposals by town decision-makers. The checklist should relate directly to the objectives and policies set forth in the land use plan.

(4) Where there are currently no time limitations for actions by town decision-makers on development proposals, limits should be established and officially adopted. This would let decision makers know specifically when their opinions are due and would also let the developer know what time frame to be thinking of when contemplating new construction. For similar reasons, a

Increasing sewage outflows from Wrightsville Beach have had adverse effects on nearby fishing areas.

Photo by Glenn Harbeck

time limit should be imposed on construction completion following issuance of the building permit.

(5) The permit process diagrammed in this article should be adopted and made public by the town board. The process should be described in written as well as graphic form.

(6) More of the policies of the director of the Land Use, Development, and Building Department need to be documented or referenced by subject index to the town's present permit filing system. This would shift more responsibility for ordinance enforcement from the director's shoulders to town records.

"...if the burden for better growth management is to be placed on any government body, it is the North Carolina General Assembly."

The staff and budgeting levels of the Sanibel plan far outdistance the financial capabilities of most small towns. While such towns may not be able to conduct the extensive research and scientific studies that form the carrying capacity basis for the Sanibel plan's performance standards and develpoment regulations, they can benefit from the plan as a model which has put many of the ALI recommendations to actual use. The plan will be particularly valuable to barrier island or seaside communities yet to experience severe development pressures.

While some municipalities may not choose or be able to use natural science statistics as their basis for development controls formulation, they will nonetheless find the types of studies valuable for decisions about capital improvements and public services investments and their environmental impacts. Communities may find university level classes willing to conduct the needed environmental investigations at no cost to the town. Another alternative might be the use of student internships for academic credit. Many states, including North Carolina, have unpaid academic internship programs already in operation.

The Sanibel plan, considered the most comprehensive of any plan completed under the Florida Act (as of February, 1977) (O'Connell 1977), is currently facing and will continue to face lawsuits from land owners and developers. This is not uncommon when new controversial land use controls are instituted. It will be useful if these challenges and court rulings become documented and published for examination by other communities with similar problems.[5]

The Sanibel *Comprehensive Land Use Plan* provides one answer to the following request:

> Both the planners and the electorate are pleading, in effect for an overall development policy which will, once and for all, determine the character of a community. In other words, they are asking for a "comprehensive plan" that has teeth. Where it has teeth, the plan itself rather than simply the implementing regulations that affect a given parcel should pass judicial scrutiny. (Franklin 1975)

Notes

1. Known from various interviews and conversations with local planners, appraisals at Coastal Resources Commission meetings, etc.

2. Florida's Local Government Comprehensive Planning Act of 1975 requires that each local government in the state must prepare and adopt a comprehensive plan by July 1979. Sanibel Island's incorporation referendum of November 1974 came well before the June 29, 1975 effective date of the state act.

3. For a thorough discussion of these scientific studies and the important role they played in the development of the Sanibel Plan, see Clark 1976; Part 2, "The Natural Systems Study," pp. 17-82.

4. The N.C. Coastal Resources Commission's *Criteria for Local Implementation and Enforcement Plans* states: "The plan for local implementation and enforcement program shall include . . . a copy of all existing or proposed local ordinances relating to zoning and land use in Areas of Environmental Concern . . . in order that the Commission may determine: Whether any local ordinances are inconsistent with the approved land use plan. No plan shall be approved . . . (if) the local government unit has an ordinance inconsistent with its land use plan." (N.C. Admin. Code, Ch. 7 Subchapter 7E Section .0200 Subsection .021). Questions remain, however concerning (1) the lack of CRC review of local ordinances not affecting AEC's and (2) what constitutes an "inconsistent" ordinance.

5. Godschalk *et al.* (1976) have done this to some extent through the use of hypothetical growth management scenarios presented in *Defining the Constitutional Issues of Growth Management,* Center for Urban and Regional Studies, UNC, Chapel Hill.

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Rural Land Use Mapping by Satellite: A Case Study of Region D COG, North Carolina

One of the most important pieces of data necessary to develop an adequate analytical base for most land use and other natural resource planning is an existing land use map.

The U.S. Department of Housing and Urban Development (HUD), through its "701" comprehensive planning regulations, mandated that all applicants for HUD "701" funds have a substantially completed land use element prior to August 22, 1977. HUD "701" was one of the major sources of planning funds for the Region D Council of Governments. To comply with these regulations and continue to receive funds, Region D developed a regional land use plan for the 1,615,000 acres in its seven-county area in northwestern North Carolina.

Because planning is a relatively new concept in western North Carolina, staff personnel were preoccupied with grantsmanship for local governments and land use and natural resource education programs. It was not feasible to employ additional staff on a short term basis because Region D received only $31,000 of HUD "701" funds. Yet, to comply with the federal regulations, an accurate existing land use map had to be acquired within the budgetary and time constraints.

Selection of a Mapping Technique

Land use and environmental planners at Region D were concerned with three factors in determining the suitability of methods for producing an existing land use map: (1) cost; (2) accuracy; and (3) time frame completion. The Council of Governments was limited by the amount of money available to produce a land use map. Accuracy of mapping was of great importance to ensure the integrity of the land use plan. Moreover, planners at Region D realized that an accurate map was required for programs other than HUD 701 such as "208" water quality planning and industrial site selection. Quick turnaround was necessary because HUD 701 guidelines required that the land use element be substantially completed by August 22, 1977.

Region D is mountainous and heavily forested, with imprecise drainage patterns typical of much of the land in western North Carolina. Manmade features included limited highway networks and sparse population patterns. The physiographic and manmade characteristics of the region greatly influenced the choice of map production techniques because of their effect on cost, accuracy, and time of completion. Three basic options were considered to compile the existing land use map: (1) windshield survey; (2) aerial photography/interpretation; and (3) satellite imagery/computer processing.

Windshield Survey—The cost of a windshield survey was estimated at between $15,000 and $20,000 for the 2821 square miles of surface area within Region D, or approximately 5 to 7 dollars per square mile. The time necessary to complete a quality windshield survey was estimated to be 10 man-months which was much too long for the combination of time and manpower available. The accuracy of a windshield survey was also questionable because of the poor road systems within the region. Many areas that were important from a natural resource standpoint contained no roads at all. A windshield survey was impossible in these areas.

Aerial Photography Interpretation—The latest aerial

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photography of the entire area within Region D was flown in 1964 by the U.S. Soil Conservation Service. This photography was considered outdated for accurate land use analysis. A new flight of the region was estimated to cost approximately $35,000, or more than 12 dollars per square mile. After the photography was processed, it would have to be supplemented with ground cover analysis made by a skilled photo interpreter at additional expense. The total completion time using this method was estimated at one year.

Satellite Imagery/Computer Processing—Imagery from the National Aeronautics and Space Administration's (NASA) LANDSAT Satellite Program was readily available for the entire Region D area. The cost of the imagery, which was available from the Earth Resources Observation System (EROS), a program of the Department of Interior dealing with the inventory and management of remote sensing data, was estimated at $200. Computer processing through a private sub-contractor would add another $63,000, or a total cost of $2.30 per square mile. Accuracy in determining the correct land use and its location would be at least 90 per cent and the completed map would be available within 120 days. However, transportation systems and small isolated acreages of urban development and other land uses were not always distinguishable using the satellite imagery/computer processing system. The imagery would have to be supplemented in these areas with additional information.

Satellite imagery was chosen as the most cost-efficient, accurate, and timely way to obtain an existing land use map. In addition, it was known that end products could include: (1) custom-selected land use categories; (2) color-coded land use maps based on one-acre increments; and (3) area tabulations which would indicate the land area occupied by selected land uses over predetermined spatial limits.

Imagery was requested for the seven county area of Region D from EROS. After screening for clarity, cloud

"Satellite imagery was chosen as the most cost-efficient, accurate, and timely way to obtain an existing land use map."

cover, time of year and time of day, an image dated April 16, 1976 was selected for computer processing. Region D contracted with Bendix Corporation's Aerospace Systems Division in Ann Arbor, Michigan to process the required data.

How the Satellite Works

The Earth Resources Technology Satellite (ERTS), later renamed LANDSAT, was sponsored by NASA and placed into orbit on Sunday, July 23, 1972 from Point Lobos, California. The satellite has been passing over every portion of the earth once every 18 days at an altitude of approximately 570 miles. A second satellite was placed in orbit in January, 1975. As the satellites pass over the earth they perform "remote sensing" (the measurement of certain characteristics of an object without touching it). LANDSAT produces imagery of four of the wavelength bands in the energy spectrum, and records this information on tape drives on board the satellite. At appropriate times, information is transmitted to earth tracking stations throughout the world and recorded. The smallest picture element or "pixel" recorded covers a ground area of 57 x 79 meters, or approximately 1.1 acres.

The satellite senses the amount of energy reflected by different land and water features. Objects with different physical and chemical properties radiate different amounts of energy in the form of electromagnetic wavelengths called "signatures."

Computer Processing

Region D staff was required to provide certain information to Bendix before any computer processing could begin. Two basic work programs had to be completed. In the first work program the local staff defined land use categories that would be the most helpful for land use analysis at the regional scale and would be distinguishable from the satellite images. After consideration of the

"The satellite senses the amount of energy reflected by different land and water features."

systems involved and the end products needed, the following categories were derived:

1. *Urban Developed*—Areas with land use of 60 to 80 percent impervious material. May include varying types of buildings, parking lots, etc.
2. *Deciduous*—Areas having primarily deciduous vegetation.
3. *Mixed Vegetation*—Areas of deciduous and evergreen trees.
4. *Open Field/Pasture*—Areas currently in grass cover.
5. *Bare Soil*—Areas recently disturbed through plowing or some other ground disturbing activity.
6. *Mining*—Areas affected by any mining activity.
7. *Water*—Lakes, ponds, and portions of rivers equal to or larger than 1.1 acres.
8. *Unclassified*—Areas not falling into the above seven categories.

In the second work program, the Region D staff located 40 acre homogeneous plots of each of the requested land use categories. These "training sets" were photographed and located precisely on Standard USGS 7½' quadrangle maps for latitude and longitude coordinates.

The electromagnetic signatures stored on tape in numeric form were then processed by a sophisticated algorithm. The algorithm, a type of multivariate categor-

A LANDSAT map of the mountainous terrain in western North Carolina was made with satellite photos.

Photo courtesy of North Carolina Department of Natural Resources and Community Development

ical analysis, carries out a series of operations: (1) Training—Interprets each training set for a typical electromagnetic signature of the particular land/water use; (2) Analysis—Each pixel is then analyzed for its unique signature and mathematically placed within the land-/water category with a similar signature; and (3) Display/Testing—Each land/water category is assigned a color code and areas are displayed on a television screen for investigation.

Final Products

Region D received a final color coded land use map from Bendix at the end of the 120 day contract period. Final mapping was scaled at 1:126,720 which corresponds to North Carolina Department of Transportation Highway Maintenance Maps.

Land use/area tabulations were also provided. When categorized land use maps were completed, Region D requested that the number of acres in each of the land use categories be produced for each county. This process, called digitization, was employed only for county boundaries. In the future, Region D planners could analyze the digital files again and retrieve land use/area tabulations for any physical or political delineation. Examples of areas that could be analyzed are townships, watersheds, municipalities, and USGS 7½ minute quadrangle maps.

Limitations of the LANDSAT Base

LANDSAT imagery has resolution problems that must be recognized to prevent the information from being used inappropriately. A primary limitation of LANDSAT imagery and the computerized analysis is the satellite's inability to differentiate among urban land uses. Because the reflectivity patterns of commercial, residential, and industrial land cover are similar, the satellite and computer processing system cannot accurately discriminate among these land uses. Consequently, the most accurate method to classify residential, commercial, and industrial land uses is to aggregate them in a general category called urban. Since the predominant construction materials associated with the three urban uses are similar, the limitations of the system are understandable. In addition, low density or heavily forested residential development is also confused with timber land and pasture uses. Another limitation of the processing system is that LANDSAT data must include an uncategorized classification which is composed of land uses that are not discernable by the computer. Since the uncategorized class comprises less than 1 per cent of Region D, this limitation is not significant.

Overcoming the Limitations of LANDSAT

Providing the supplemental data needed to disaggregate the urban category while still preserving the integrity of the LANDSAT base became a real problem. There were two reasonable alternatives to achieve the objective.

The first alternative the Region D staff assessed was the analysis of low altitude aerial photography. Only photos of urban land uses would have to be procured because LANDSAT already covered the rural areas adequately. Estimated costs of aerial photography and interpretation of the urban areas was $5,000. The latest existing aerial photography available had been flown in 1964. The second alternative would utilize windshield surveys of urban land uses along the highway systems. Additional information about urban land uses could be

"In the future, Region D planners could analyze the digital files, and retrieve land use/area tabulations for any physical or political delineation."

acquired from North Carolina Department of Transportation "County Cultural Maps" which depicted all the urban development outside incorporated communities. The "cultural maps" were slightly outdated since most of them were compiled in 1972, but they were good enough for a regional land use plan because of the area's lack of growth. The information from the "cultural maps" and windshield surveys could be incorporated into an existing land use map which would rely on LANDSAT imagery for the natural resource component. The windshield survey costs were estimated to be less than $1,000 for the entire region. Because there was insufficient funding to rephotograph the area and hire a

photo interpreter, the windshield survey method was chosen.

It is important to note here that the efficiencies of using LANDSAT data in combination with aerial photographic analysis or windshield surveys could be lost in areas with a substantial amount of acreage in the urban category because much more time would be spent compiling and analyzing the supplemental information. However, Region D municipalities cover less than 1 percent of the total acreage so the method chosen was cost efficient.

The Bendix Corporation has initiated efforts to overcome the problem of resolving urban land uses by analyzing, digitizing, and presenting aerial photography using 1.1 acre "pixels." The process basically involves cleaning the digitized tapes obtained from the satellite in the urban areas and then redigitizing them using information obtained from low altitude aerial photographs (Reed and Enslin 1977). Then, the tapes are processed in the usual fashion. This analysis does add cost to the contracting party.

Presentation of the Supplemental Information

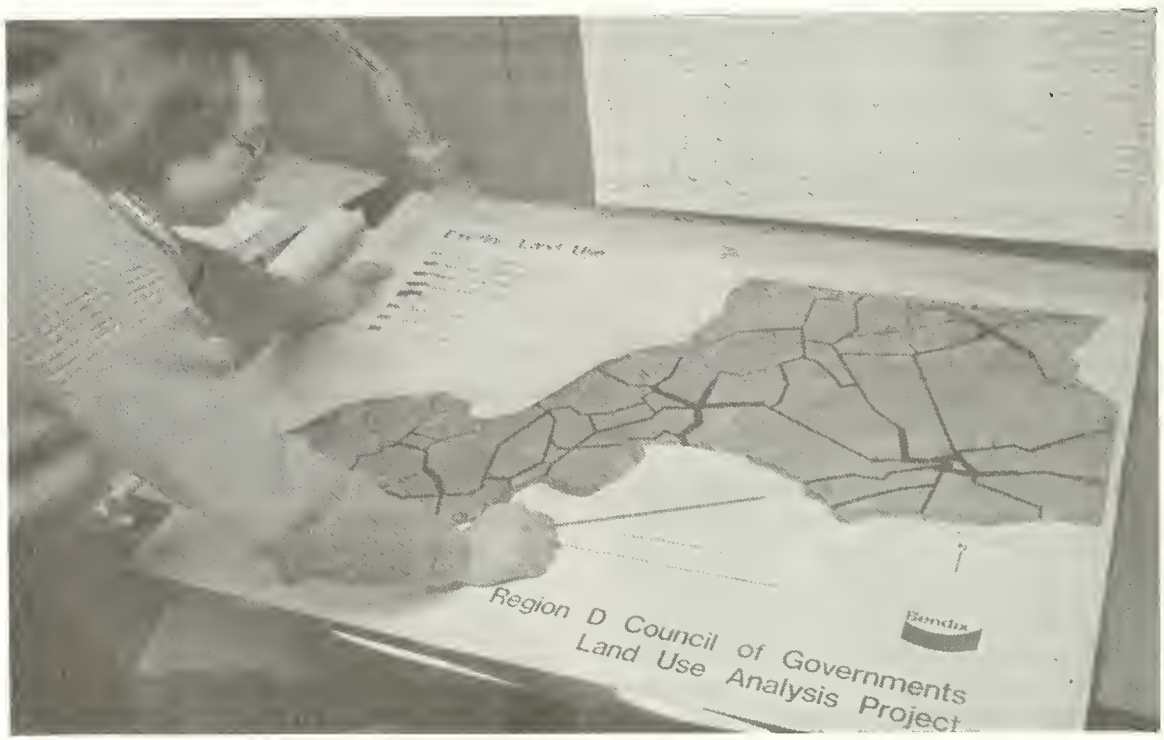
The technique used to present the supplemental urban information on the LANDSAT base was borrowed from an idea used in the "Subregional Overview Project" developed by the Tennessee Valley Authority (TVA), Division of Navigation and Regional Studies (Division of Navigation Development and Regional Studies 1975). The TVA technique basically involved accentuating important features of a base map derived from high altitude photography using diazo overlays. In Region D's case, the base map was provided by the computer enhanced LANDSAT imagery. The overlays were developed rather inexpensively. All that was needed was graphic talent, drafting supplies, and access to a blueprint machine to ensure the availability of important natural resource information and still gain the more specific residential, commercial, and industrial information that would be needed for the land use planning effort.

The advantages of developing the land use map in this manner are: (1) the existing land use map would be as specific as county or regional land use planning would require; (2) important relationships between urban and nonurban uses in remote areas could be shown; and (3) McHargian methodology (McHarg 1969) could be used to develop the plan by providing additional overlays showing environmental and human factors of importance which could easily be understood by the non-technical audiences that would view the plan.

Aerial photo interpretation could have been used to develop the map in the same manner, but not as cheaply. However, the necessity for supplemental urban information would have been less with photography than with LANDSAT imagery.

LANDSAT's Relevance to Water Resources Planning

LANDSAT imagery is potentially valuable in water resources planning as well because the data can be analyzed for any desired spatial limits. Watershed or river basin data are as easy to digitize as state or county data. The number of acres in each land use category such as urban, deciduous forest, cropland, pasture, and mining can be called off the tapes within any designated



The LANDSAT map can be used as a basis for making overlays.

Photo courtesy of Region D Council of Governments

spatial limits. If the land use data is combined with soils and slope angle and length information, models can be developed estimating flows, runoff, sedimentation, suspended solids, and other wasteload factors closely related to existing land use.

Soil erodibility, slope angle, and slope length are relatively static and large scale modification of these three factors is normally not feasible, at least on a short term basis. However, land use is constantly changing, which provides a means for controlling and monitoring potential nonpoint sources of pollution. Future waste loads can be estimated by simulating future land use patterns. The Triangle J Council of Governments used LANDSAT data extensively in their "208" study (Rogers *et al.* 1975).

> "Using LANDSAT imagery has its greatest advantages in rural areas of significant size."

Computer techniques can also be used to digitize elevation and detailed soils data. Elevation data, used for calculating slope angle and slope length data, is supplied on computer compatible tapes by the National Cartographic Information Center of the United States Geological Survey. This data was initially derived from the 1:250,000 scale topographic map series by the U.S. Department of Defense to avoid negative effects of elevation on radar tracking. Information from detailed soils surveys can also be digitized. The scale and resolution of the LANDSAT data are similar enough to the resolution and scale of digital soils and terrain data to enable the three data sources to be composited for multidimensional analysis.

LANDSAT imagery can be very useful at an even larger scale such as the Water Resources Council, Level A and B studies compiled on a statewide and river basin level, respectively. Land cover and water quality factors can be monitored generally but cheaply over these large areas.

Other Uses of LANDSAT Data

LANDSAT data has a variety of other uses especially where large areas have to be monitored frequently. LANDSAT data can be updated every 18 days, provided there is no cloud cover. LANDSAT can be beneficial in mapping fault zones and potential mineral sites. Satellite imagery is especially effective in monitoring floodways, wetlands, snow cover, and forest fires where the spatial limits vary widely over short time spans. As long as knowledge of specific urban uses such as residential, commercial, and industrial are not needed, LANDSAT can also be used to monitor urban change.

Advantages of Using a LANDSAT Base

Using LANDSAT imagery has its greatest advantages in rural areas of significant size. Land use in large regions can be monitored more quickly and cheaply using LANDSAT than with any other technique. The accuracy of LANDSAT is comparable to other methods, except in urban areas. In rural areas, where population density is low and funds for land use mapping are limited, computer processed LANDSAT imagery is an excellent alternative to aerial photographic analysis, especially where natural resource applications are important. If computer simulation of land use information is desired, LANDSAT imagery is extremely valuable because it is already digitized on computer compatible tapes.

The Future of LANDSAT Imagery

As techniques of determining land cover from satellites become more refined, satellite data will become more useful. Already plans are being made to launch a new satellite that will monitor a greater portion of the infrared spectrum, which should provide even more information about land use. The new satellite will also have a thermal scanner on board. Because different types of vegetation emit different levels of heat, even more accurate land use data are expected. More extensive analysis of the infrared spectrum and use of the thermal scanner should improve the urban resolution problem. However, many more improvements will need to be made before satellite imagery can distinguish among urban land uses. As processing technology becomes more refined, even greater resolution will be possible because the pixel size is expected to be smaller, which should make satellite imagery even more accurate. The changes in technology will probably come quickly, and satellite imagery will provide even more information that can lead to more accurate predictions and planning.

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Measuring Public Values in Environmental Assessment

With the passage of the National Environmental Policy Act of 1969 and many corresponding state-level acts, environmental assessment has become an important component of environmental planning. A number of assessment techniques have been developed and range from simple matrix analysis of static, direct cause and effect relationships to computer simulations based on grid systems (Lapping 1975). Most of these assessment methodologies are highly technical, but in some of them, the matrix being the foremost example, there is an attempt to weigh technical evaluation of impact with social judgments about the value of the affected environmental features.

This latter approach to environmental assessment presents a number of interesting methodological problems. Most obvious is the problem of determining the value of environmental characteristics. That is, are these values measurable from the subjective perceptions of people about their environment; for example, in comparison to the environmental amenities of other locations (Craik and Zube 1976).

A second problem is the issue of who should make this value choice. Is it a matter of consumer preference, something that can be ascertained through survey or a type of market research, or instead is it the province of the expert, who is usually the project consultant, to make the decision? The latter alternative may be the easier one to use in the course of a project evaluation, but it certainly is questionable whether it can be claimed that the judgments are reflective of community sentiment.

A third problem may be less complex and relevant only if the above two have already been solved. If the value of the environment has been measured according to some scale, then it becomes a matter of combining this data with technical evaluations to provide an overall assessment of the project's impact.

In this paper, the question of using public perceptions in environmental assessment is approached from two perspectives. First, matrix analysis, an approach to the determination of environmental values, is described and other approaches which utilize citizen input are briefly analyzed. In the second part, research findings from a study conducted on a public development project are discussed. The research design was based on a matrix and community responses were employed to measure the value of the environment to local residents.

Problems and Strengths of Matrix Assessment

One of the values of matrix assessment is its simplicity and ease of application. The matrix structure provides a clear and straightforward organization and allows a rudimentary classification of cause-effect relationships. The Leopold *et al.* (1971) model is the best known of these approaches. The matrix is comprised of 100 categories of actions and 88 environmental characteristics that can be affected by these actions. This matrix produces 8,800 cells, each of which identifies an environmental impact. For each cell, two values are assigned. A magnitude estimate is made for the level of impact and this score is weighted by a subjective judgment about the value of the environmental characteristic that is being affected.

It is the latter characteristic of matrix assessment, the assignment of community values to the environment, that is of interest to the social scientist. This methodological approach provides a way to interject community attitudes into the planning process and to integrate technical and social data into a comprehensive summary of a project's impact.

Matrix analysis, however, is not without its shortcomings, especially on the technical side of evaluation. The size of the matrix, 8,800 cells in the Leopold model, can make concise analysis very difficult (Fischer and Davies 1973, p. 211) and often results in nothing more than an inventory of probable impacts (Lapping 1975, p. 125). The analysis is cross-sectional in time so longitudinal or seasonal changes in the environment that might change the nature of the impacts are not analyzed (Fischer and Davies 1973, p. 211). A related problem is the direct cause-effect nature of the analysis. Cumulative, synergistic and higher order impacts are not identified (Lapping 1975, p. 125-126).

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Another area of controversy in matrix assessment, which is more germane to the purposes of this paper, is the assignment of subjective values to environmental characteristics. Leopold (1974, p. 31) has stated that scientists should make the technical and social value judgments in matrix assessment. In the latter role, the scientist has become the surrogate representative of community values. There are two important questions that stem from this role assignment to the scientist. One question is normative, the other empirical. First, should it be the role of the scientist to be an arbitrator of social values? It would seem presumptuous to say yes, since he is not acting as a member of a social community in his role as evaluator, but as a member of a professional community with norms very different from those of the former. McElrath (1973, p. 56) has made this point. His view is that the primary client of the professional is government and the public is a "distant, secondary client dimly viewed through an organizational screen not directly related to their activities."

"This methodological approach provides a way to interject community attitudes into the planning process and to integrate technical and social data into a comprehensive summary of a project's impact."

The empirical question is not whether the scientist should make the decision, but how he can make it. Even if we accord him the right to make this judgment, can we really expect him to adequately make an assessment of community values? What standard will he use and how will he apply it? Maybe Plato's philosopher king could adequately perform this role, but I am somewhat reluctant to concede that the scientist as consultant has the perspective that Plato gives to his ruler.

In contrast to Leopold's attitude toward determination of the importance of environmental characteristics in matrix analysis is the position taken by social scientists working in the area of environmental perception and behavior. Craik and Zube (1976, pp. 3-23) have called for the development of standardized indicators of environmental quality based on human perception, which they refer to as Perceived Environmental Quality Indices (PEQIs). It is their position that the measures can provide a complementary set of indices to physically-based ones, serve to increase our understanding of the relationship between man and his environment, and provide an alternative method of project-related environmental assessment.

Substantial research has been conducted on the development of such indicators and the validity and reliability problems associated with them (Craik and Zube, 1976). The problem of community perception of environmental values in matrix assessment is a related research question and the same type of methodological considerations should apply. Matrix evaluation would not be based on a generally accepted set of indices as exemplified by Craik and Zube's concept of PEQIs, but would be project-specific. The same measurement issues apply, however, and data could be gathered in the same way whether through verbal surveys or graphic simulations of an environment.

Survey techniques have been used in other types of assessment methodologies to measure environmental values. One such methodology has been developed by Burnham, Nealey and Maynard (1975) for the siting of nuclear power plants. This approach employs respondent evaluations of project alternatives as weights to technical judgments on environmental impact. The researchers present the respondents with "mini-environmental impact statements" for hypothetical power plant options. Each statement describes the impact of each alternative according to eight criteria: aesthetic, land use, water, air, economic, cultural/-recreational, health/safety, and animal/plant. Visual representations are also used in areas like aesthetic values where verbal descriptions prove inadequate. In contrast to the matrix approach, respondents are instructed to rate project alternatives according to their level of acceptability.

In matrix assessment, a sample of community residents would only indicate the value of a particular environmental attribute to them. Identification of project alternatives and their impacts would not be a part of a matrix evaluation. In this regard, the matrix approach is much less comprehensive in the level of community input it provides, but highlights basic project-environment relationships that make it easier to communicate information about impacts. In doing so the matrix approach facilitates community involvement in the environmental planning process.

An Exploratory Application of Matrix Assessment to an Airport Development Project

Under a grant from the Environmental Studies Council, University of North Carolina, research was conducted on the application of the Leopold matrix to the Raleigh-Durham airport development project and the

Resident attitudes towards the nearby airport were measured.
Photo by Blair Pollock

use of this information as the basis of a questionnaire measuring environmental preferences. The goal of the research was to determine if it is feasible to derive social rights from a matrix assessment methodology.

The environmental parameters that are focused on in the questionnaire are of three types: resources, problems, and processes. Resources refers to environmental amenities like parks, employment opportunities, health and safety, and forests. General land use patterns are also included in this category. Aircraft noise is an example of a problem. Some processes are soil erosion, compaction and deposition, and aquatic cycles. Air and water quality could be resources, problems, or processes depending upon the pollution level in the area. Individuals respond according to their perceptions of the value or significance of a particular environmental feature of the area. For example, a concern over erosion is likely to be a function of how a person values water and land quality.

"...research was conducted on the application of the Leopold matrix to the Raleigh-Durham airport development project."

Interviews were conducted with a random sample of local residents to gather this information. Respondents were not asked to estimate the degree of impact they thought the airport would have on the environment. They were simply required to indicate whether they thought an environmental resource was an important one or that a problem was significant. The technical judgment about the level of impact is the decision made by the expert and is a separate evaluatory process. The choices made by local citizens represent the priority or weight that should be given an environmental feature in the planning process, quite apart from the degree of impact that a project alternate could have on it.

This dual definition of environmental quality, impact and value, provides an approach to environmental assessment that is analogous to cost-benefit analysis in economics. For example, a proposed project alternate could result in a significant disruption of an ecological system. Yet if the affected residents do not place high priority on this aspect of their environment, should the alternative be abandoned solely on the basis of the "objective" assessment? A negative decision of this type, while justified on technical grounds, would not be an accurate reflection of community sentiment. Given the low valuation placed by residents on this environmental attribute, a preferable alternative would be to weight the technical assessment with the environmental preferences of the public. This approach would provide an integrated "community-expert" profile of a project's anticipated environmental impact.

It should be noted that the use of citizen perception as the basis of determining environmental value is based on the assumption that the network of costs or benefits that derive from a particular environment are internalized by the public most immediately affected by the proposed project. This assumption, although a necessary one for purposes of this methodology, is questionable for environmental problems, like air or water pollution. Environmental resources generally have a component affecting a larger segment of the population outside the locality. The question of value extends further than the preferences of local residents and places constraints on the applicability of this matrix technique to projects that affect features of the environment that have broad geographic significance.

With these limitations in mind, the Leopold matrix was applied to the Draft Environmental Impact Statement (DEIS) issued by the Federal Aviation Administration on the proposed Raleigh-Durham airport expansion. The approach identified 240 environmental impacts from the 5 project alternates considered in the document.

In Figure 1, the types of impact are identified. The most frequently occurring impact is on physical processes like flooding, soil erosion, deposition, and compaction. Twenty-two percent of the impacts are in this category. Water-related problems are the second most frequent impact. Runway construction will necessitate construction of dams filling some marshes in the area. Aircraft noise, the most publicized environmental impact from airports, accounts for just four percent of the total number of impacts.

A major limitation of the Leopold matrix is the lack of specification of synergistic and secondary environmental impacts. Aircraft noise is an example. It is an effect of airport expansion if air traffic is increased or different flight patterns are adopted due to runway relocation. Residential neighborhoods may be exposed to higher noise levels in either case. Additionally, there is some evidence that aircraft noise can depress residential property values (Gautrin 1974; McClure 1969) and so it can function as a cause or independent variable. Noise from aircraft can also combine with surface traffic noise to produce a synergistic effect on the ambient noise level in a neighborhood.

This example clearly demonstrates the simplified nature of matrix analysis. The technique, however, does allow basic categorization of cause-effect relationships and this could be sufficient in some cases for construction of a questionnaire to measure environmental values. The problem is that if higher order or synergistic causes have not been specified, then all the consequences of the action have not been identified. The questionnaire would not reflect all the features of the environment that might be affected by a project action in this type of multiple cause-effect pattern. The validity of matrix survey questions ultimately depends upon the thoroughness of the determination of the impacts by technical experts. Sorenson's (1972) attempt to develop a matrix which deals with the multiple and interactive causal dimensions of environmental impacts represents a substantial improvement over Leopold's more direct causal model.

A methodological implication for questionnaire design from an approach which identified cause-effect networks is whether a set of questions could be designed to

Figure 1

Matrix Identification of Effects of Raleigh-Durham Airport Expansion

Effects (Changes in . . .)	N	%
Physical Processes	50	21
Water	43	18
Land Use	28	12
Aesthetics	25	10
Fauna	21	9
Flora	20	8
Earth	14	6
Cultural Land Use	11	5
Noise	10	4
Man-Made Factors	9	4
Atmosphere	5	2
Cultural Conditions	4	2
Total Number of Impacts	240	100*

*Percentages do not sum to 100 due to rounding error.

accurately measure environmental preference based on systems of interaction rather than discrete elements. In the Leopold matrix, environmental features are treated as single, unrelated items. If a matrix is employed that merges these phenomena into a system, e.g., ecological or social, is it valid to ask a respondent to assign a value to the entire set of phenomena? With a large number of elements in the system, there would always loom the internal validity problem of "are we measuring what we think we are measuring?" That is, on what basis would the respondent be making his decision: the system in its entirety or a particular element of it that he might think important?

Problems in Questionnaire and Scale Construction

The first problem in constructing the questionnaire was the number of impacts. Two hundred and forty items are too many for any type of sample survey, including a personal interview. Since there were multiple causes for a single effect, it was possible to reduce this to a single item. Pre-testing of the questionnaire also showed that inclusion of the causal action along with the effect tended to confuse the respondent. When a cause was identified, the respondent often tried to make an impact judgment rather than simply estimating the value of the environmental characteristic. This problem did not occur when only effects were listed.

Identification of the location of the impact proved to be a problem. With many physical, air, and water processes, the location of the actual impact could not be isolated to a single place. Therefore, for these processes, it was necessary to include the location of all the probable impacts. In most other cases where a physical process was not involved, only one locational variable was specified since the effect seemed to be isolated to a particular area.

Seventy-three impacts were included in the final version of the questionnaire. They ranged from controversial issues like "aircraft noise over Raleigh and Cary residential neighborhoods" to straightforward items such as "soil composition surrounding runways on airport property."

The measurement scale used in the questionnaire was a "Q-sort." Each of the seventy-three environmental parameters were listed on a separate card and the respondents were asked to sort them on a ten-point scale ranging in value from important to unimportant. The cards could be re-sorted any number of times, providing the respondent with flexibility in his ranking of the environmental attributes.

The advantage of a Q-sort is that it allows the respondent to make comparisons between items in assigning them ranks. Scales based on comparative appraisals produce less variability in respondent choice than preferential judgment scales where rankings are made on a single issue-by-issue basis (Craik and Zube 1976, pp. 14-20). The issues themselves are the frame of reference with the Q-sort technique, although the usual procedure in using comparative appraisal scales to study environmental perception has been to ask respondents to evaluate a particular setting against settings that possess different characteristics (Zube 1974). This latter approach is more complicated since many more elements have to be introduced into the research design and thus would limit the ease with which the technique could be applied by planners.

Data Analysis

This exploratory survey was administered in July, 1977, to 130 residents of Cary, North Carolina. This community was chosen as the sampling area because most of the city was within the zone of lowest noise level where land use impacts have been established (Federal Aviation Administration 1971, p. 49).

"A major limitation of the Leopold matrix is the lack of specification of synergistic and secondary environmental impacts."

To determine the priority of the seventy-three environmental attributes, a coefficient of variation was computed for each item and the attributes were ranked according to this value. This measure is based on the mean and standard deviation, thus allowing the average score for a given item to be weighted by the level of agreement among the respondents on its importance. Using a mean to determine an item's priority is a misleading statistic if there was substantial variance in the distribution of the scores. The importance of an environmental feature should be a function of the level of consensus on its significance as well as the value assigned to it on the ranking scale.

The level of consensus on the value of an environmental dimension has been emphasized in the literature on environmental perception. A higher level of agreement among the public over particular issues or problems provides a more reliable data base on which to make policy decisions (Craik and Zube 1976, p. 18).

There are a number of ways to analyze the data. For the purposes of this paper, the rankings of the issues will be examined according to the type of environmental problem and resource and its location. This type of analysis would be the method employed in matrix assessment. Alternatively, questions can be asked about the pattern of individual responses. Studies indicate that environmental perception is a function of many background variables: political ideology, environmental knowledge, education, and lack of personal efficacy (Arbuthnot 1977); self-confidence and esteem (Kaplan 1977); and occupation or role (Althoff and Grieg 1974; Constantini and Hanf 1972). For example, in this survey did the respondents tend to group certain types of impacts together in that they assigned them all similar scores? A pattern of this type would suggest that they viewed the impacts from perspectives that reflected broader concerns such as conservation, recreation, economic development or even environmental ideology (see Tognacci *et al.* 1972).

Questions comprising nine attitudinal scales were also included in the survey which measured attitudes toward such dimensions as aesthetic values, environmental regulation and utility, business, technology, and ruralism. Responses to the seventy-three environmental issues identified by the matrix can be correlated with these scales to determine whether general attitudes toward the environment and other phenomena affected what issues the respondents thought were important. These questions about background and attitudinal correlates of the matrix responses, although important, will not be discussed in this report on the study's findings. In the subsequent discussion, the emphasis will be placed on analysis of the data in a matrix format.

Individual-Level Environmental Parameters Ratings

In Figure 2, the rankings for the top 25 percent of the issues (ranks 1-18) appear. There is a fairly even mix of issues dealing with the physical and biological dimensions of the environment along with cultural elements, although the latter factors tend to be ranked higher. This combination of issues indicates a concern among the respondents with both the natural and social environment. The social dimension of environmental impact has been increasingly stressed in discussions of environmental assessment. For this reason, the analysis of the rankings will focus on the social factors.

The Federal Aviation Administration in a recent circular (U.S. Department of Transportation 1975) emphasized the importance of estimating cultural impacts from airport development projects. Among the social impacts which were identified as items that should be considered in an Environmental Impact Statement (EIS) were direct effects of surface traffic disruption on community socio-economic structure (roads and highways was ranked 18th in this survey) and indirect impacts such as population movement and growth, and public service demands (waste disposal and public utility use were ranked 2 and 6, respectively).

The highest ranked issue is an example of a broad cultural dimension, health and safety. The respondents most likely perceived this environmental problem in a general sense without special reference to the airport. However, there is a direct impact on community safety that is produced by an airport. Operational malfunctions like an airplane crash can result in a severe disruption of a community. Nevertheless, the probability of such an occurrence is very low, so this issue would be an example of an environmental dimension that would receive a

Figure 2

Ranking of Environmental Parameters (Top 25 Percent)

Rank*/Environmental Parameter**/Type)***

1. HEALTH AND SAFETY OF POPULATION in Wake and Durham Counties (CC)
2. WASTE DISPOSAL in Wake and Durham Counties (MMF)
3. RESIDENTIAL LAND USE in Wake and Durham Counties (LU)
4. AIRCRAFT NOISE in Raleigh and Cary Residential Neighborhoods (N)
5. EMPLOYMENT OPPORTUNITIES in Wake and Durham Counties (CC)
6. PUBLIC UTILITY USE in Wake and Durham (MMF)
7. INDUSTRIAL LAND USE in Wake and Durham Counties (LU)
8. LAND ANIMALS AND THEIR HABITATS on Airport Property, Airport Periphery and in Umstead Park (FA)
9. FLOODING AROUND STREAMS on Airport Property, Airport Periphery and in Umstead Park (P)
10. EROSION ALONG STREAMS on Airport Property, Airport Periphery and in Umstead Park (P)
11. STREAMS in Northwest Raleigh (W)
12. WASHING OF DIRT INTO STREAMS on Airport Property, Airport Periphery and in Umstead Park (P)**
13. COMMERCIAL LAND USE in Wake and Durham Counties (LU)
14. AIR QUALITY over Airport Property, Airport Periphery and Umstead Park (AT)
15. STABLE SOIL CONDITIONS ALONG STREAMS on Airport Property, Airport Periphery and Umstead Park (P)
16. INDUSTRIAL LAND USE in Research Triangle Park (LU)
17. WATER CYCLE (PRECIPITATION, FILTERING AND EVAPORATION) on Airport Property, Airport Periphery and in Umstead Park (W)
18. ROADS AND HIGHWAYS in Airport Property (MMF)

*Coefficients of Variation ranged from 22.9 (rank no. 1) to 40.4 (rank no. 18). The coefficient for the 73rd ranked issue (the lowest rank) was 67.6.

**For many of the environmental parameters relating to physical processes, the terminology was simplified for purposes of the questionnaire.

***The general category of effect for the specific environmental parameter is listed in the parentheses. The abbreviations refer to: (AE) Aesthetics, (AT) Atmosphere, (CC) Cultural Conditions, (CLU) Cultural Land Use, (E) Earth, (FA) Fauna, (FL) Flora, (LU) Land Use, (MMF) Man-Made Factors, (N) Noise, (P) Physical Processes, (W) Water.

high social value weighting, but the impact score, derived from an estimate of the risk and magnitude of the event, would be low. The problem of weighing risk versus magnitude in determination of a single impact score is not simple. As in the case of nuclear power plants, the likelihood of catastrophic event is very small, but its magnitude could be enormous. How this decision might be made is beyond the scope of this paper, but the example serves to illustrate a typical problem encountered in matrix assessment where a single impact score has to be assigned for an environmental parameter that has multiple dimensions.

Among the top eighteen ranked issues (25 percent) are four that deal with land use around an airport. These issues are examples of environmental dimensions that would likely receive high impact along with high value scores although the direction of the impact could be positive or negative.

The relationship between airports and land use in their periphery is a complex, multi-faceted problem. Airports can exert a major economic influence on their environment through direct, indirect and secondary employment (employment opportunities was ranked 5th in the survey), and purchase of goods and service. The economic stimulus provided by airports creates a high demand for commercial land and residential housing in their periphery (U.S. Department of Housing and Urban Development 1972).

In contrast, aircraft noise has an adverse effect on existing residential neighborhoods. Its effects include residential turnover and reduced demand for single-family dwellings (Environmental Studies Board 1971, p. 105), and lower residential property values (Gautrin 1974; McClure 1969). The importance of this environmental dimension of the airport's expansion is clearly shown by the high ranking (4th) given aircraft noise in Raleigh/Cary residential neighborhoods.

"The importance of an environmental feature should be a function of the level of consensus on its significance as well as the value assigned to it on the ranking scale."

The evaluation of the actual impact of the airport's expansion, as described above, can be problematic. The difficulty is not always estimating the actual magnitude of impact, but in determining in which cases (e.g., project alternates) it is negative or positive. Most matrix systems use a plus or minus value to indicate the direction of impact. The dilemma posed by the airport's land use impacts, for instance, is that positive and negative land use impacts often occur in the same section of a community. It may not be possible to empirically separate these effects so the analytic requirement in the Leopold matrix that they be treated separately may not adequately summarize the nature of the impact.

Besides aircraft noise in Raleigh and Cary residential neighborhoods, there are six other environmental parameters that deal with aircraft noise. For these remaining issues the problem is perceived as not particularly important. Surprisingly, aircraft noise in a state park (Umstead) located adjacent to the airport is considered even less of a problem than noise over airport property. One reason is the high variance among the respondents on its priority. It has the third highest standard deviation for the seventy-three environmental dimensions. If the mean alone were used to rank the issue, its position would be 49.5, somewhat higher. To some degree, the low level of concern evidenced by the respondents over the noise problem in the park may be a result of the present noise levels, which are substantial in some parts of the facility. Local residents may consider this noise level as a "natural" characteristic of the park, since it is located next to an airport and is unlikely to be relocated.

Citizen perceptions are used to help determine the environmental value of natural areas like this one near the Raleigh Durham Airport.

Photo by Blair Pollock

In contrast, the high rank of aircraft noise in Raleigh and Cary residential neighborhoods probably reflects more of a concern about the future than an assessment of the present noise level. Residents value quiet neighborhoods and the level of exposure to noise under current operating conditions is minimal. Hence, the high ranking given this environmental dimension likely reflects a concern with conserving an existing resource, residential peace.

Aircraft noise in another residential area, Durham, is ranked much lower. This ranking is predictable since the survey, due to its exploratory nature, was restricted to a community in the Raleigh area. If a representative cross-section of citizens from the Raleigh-Durham metropolitan area were used, this issue would likely be ranked much higher.

In terms of physical attributes of the environment, the respondents expressed substantial concern over flooding and erosion problems and related water dimensions. Stream and runoff problems have been a major environmental issue in the Raleigh area since two major floods occurred in 1973. The issues, although important to residents, would probably receive low impact scores. For all the project alternates, the airport has proposed extensive sedimentation pools and dams to prevent many of these problems.

Group-Level (Effect and Location) Rankings

An alternative way to analyze the data is to group the environmental parameters according to two dimensions: category of effect, and location. In Figure 3, the data are summarized utilizing this format. There are twelve categories of effects (or impacts) ranging from a general value dimension, aesthetics, to physical processes of air, water, and earth. Location of these effects are divided into two parameters: single and multiple. A multiple location refers to an action that has an impact on a number of different geographic areas. Multiple locational impacts are common in regard to actions that affect natural processes although it is also true for some types of social impacts like land use. The location of the effects or impacts are almost equally divided between single and multiple sites.

Figure 3 indicates that most of the impacts of the airport's expansion, when the effects of the project alternates are aggregated, are predictably within the facility's boundaries. But it is clear that none of these category effects are highly ranked by the respondents. The rankings for the groups range from 48 to 67, with the average rank for airport property (across the 12 groups) being 58.

In contrast, the grouped impacts that were identified for Wake and Durham counties receive the highest ranking, 13. These issues deal primarily with social rather than natural dimensions of the environment, e.g., residential land use, density of housing, employment and health and safety. This finding again suggests that area residents are more concerned with the broad, social dimensions of their environment. In Figure 3, the mean ranks for the categories of effect are presented without reference to location. Although atmosphere (14) and water (21) are ranked first and second, the next highest ranked groups, cultural conditions (22) and land uses (26), also include many social factors.

Figure 3, although a useful way to summarize the data, is based on a number of questionable assumptions that also pertain to matrix assessment in general. For each project alternate in a matrix analysis, the total number of cause and effect relationships are identified; each relationship then receives an impact and social value score; and finally these scores are summed to give an aggregate impact score for the project. However, as done in Figure 3, it is assumed that the scores for different environmental dimensions can be added to form an aggregate or combined index.

A valid question is whether such a multi-dimensional index has any meaning since it is multi- and not unidimensional. Unlike an air or water quality index, there is no standard interpretation that can be assigned to a project alternate's score. In one case, a high score may represent mostly aesthetic impacts. For another alternative, the score may be due to impacts on physical processes. In an air quality index, a high value represents high pollution levels. Different combinations of pollutants may produce the score, but there is general agreement on the meaning of the index values. This is not the case for an index value in matrix assessment. An aggregate score does not identify the specific impact: aesthetic, physical, or combination of both. In the latter case, which one contributes more to the score? An alternative approach would be to give a project alternate a separate score on each of the twelve categories of environmental parameters listed in Figure 3. Summary interpretation would be more difficult, but the validity of the technique would be higher. It would not be necessary to make the highly questionable assumption that

Figure 3

Category of Effect by Locational Parameter Rankings

	Single Locational Parameter				Multiple Locational Parameter		
	(A)*	(B)	(C)	(D)	(E)	(F)	
Category of Effect							Mean Category Rank
Aesthetic	64(5)**	48(5)		21(2)			50(12)
Atmosphere						14(1)	14(1)
Cultural Conditions		28(1)			21(4)		22(5)
Earth				42(4)			42(4)
Cultural Land Use	56(1)					46(1)	51(2)
Fauna	48(3)					26(2)	39(5)
Flora	62(4)	49(3)					56(7)
Land Use	48(1)	36(4)	16(1)	24(1)	8(3)		26(10)
Man-Made Factors	55(3)	18(1)			4(2)		32(6)
Noise	67(1)	37(1)	27(3)	68(1)			42(6)
Physical Processes	56(3)					21(7)	32(10)
Water			11(1)			24(4)	21(5)
Mean Location Rank	58(21)	41(15)	22(5)	38(8)	13(9)	24(15)	

*Definition of Locational Parameters: (A) Airport Property, (B) Airport Periphery, (C) Durham or Raleigh or Research Triangle Park, (D) Umstead Park, (E) Wake and Durham Counties, (F) Airport Property and/or Airport Periphery and/or Umstead Park and/or Northwest Raleigh.

**Figures represent the rank and number of cases, e.g. 64(5), for a category of effects, e.g., Aesthetics, for a particular location, e.g., Airport Property.

the twelve dimensions measure the same phenomenon, which is required if the scores are added together to form a composite index.

Conclusion

In the discussion of the application of survey research methods in matrix assessment in this paper, a generally critical posture was taken toward the validity of the approach. The criticisms made, however, should not be taken as rejection of the approach. It can play a valuable role in environmental planning, but its limitations cannot be ignored.

Matrix assessment represents an "approach, not an arrival," to borrow a quote from Merton (1957, p. 9). Leopold *et al.* (1971, p. 6) make essentially the same point in evaluating the role that a matrix can play in preparation of an Environmental Impact Statement (EIS). They state: "The matrix is, in fact, the abstract for the text of the environmental assessment."

Some of the possible roles that a matrix can perform were outlined in earlier sections of the paper. By relating causes and effects in one comprehensive scheme, it provides a useful vehicle for data reduction and summary. The lack of integration in EISs has been noted by many observers (Ditton and Goodale 1972; Dickert and Domeny 1974), so matrices can provide an approach to this problem.

Secondly, when a social weighting scheme based on survey research is employed in matrix assessment, a method to facilitate the input of citizen concerns into planning is provided. The importance of this element has been stressed in a report prepared for the Federal Aviation Administration. It is emphasized that a public hearing, while a useful means to obtain citizen input, is just a first step. The suggestion is made that the next step be for the "airport operators to weight affected communities' attitudes in their own planning process" (Federal Aviation Administration 1972, p. 32). Survey-based matrix assessment provides such a weighting system and arrays the information in a form that can be combined with technical information on environmental impact. The resulting analysis, although far from definitive, introduces the citizen component into environmental planning and assessment in a systematic and representative fashion—something often missing in the public hearings and other formats that are used in an attempt to produce a process more responsive and accountable to citizen needs and perceptions.

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Determining Community Attitudes and Preferences for Programs and Services

Planning programs may fail to accomplish their goals and objectives because they do not meet the needs of the population for which they are designed. Planners may be of different socioeconomic, regional, or ethnic backgrounds from those for whom they plan. They may perceive and evaluate important aspects of the environment differently from their clients. For these reasons, individuals who will be living and working in the environment to be designed or modified by planners should be encouraged to provide input into the development of plans which will affect their activities and enterprises. A means of assessing needs and values of the community ought to be incorporated into planning projects.

Such an assessment requires the allocation of scarce resources at the beginning of a project. However, the advantages of designing projects appropriate for the people they are intended to benefit will, in the long run, outweigh greater research costs by decreasing the number of programs which are ill-designed because they did not consider the needs of the community. There are a number of ways to incorporate citizen participation into a planning project. This paper discusses one methodology, Heuristic Elicitation, in which the needs, goals, and values of a community are studied in such a way as to provide information for planners to use in designing programs and projects. It is not a direct form of citizen participation since citizens do not interact directly with planners. It may, however, be preferable to direct participation in that the community as a whole is considered through the use of survey techniques which carefully sample a population to insure representation of all its members.

Through use of the methodology, we seek to determine "culturally appropriate" designs and plans; that is, to help discover the compatibility of an introduced element with the socio-cultural patterns, goals, values, and circumstances characteristic of the population to which the new element will be available. Heuristic Elicitation utilizes a two-stage survey design which incorporates both open-ended interviews in which respondents can freely and openly discuss their ideas and concerns, and structured interviews which provide the statistical information necessary for planning efforts.

The first stage of the methodology concentrates on defining the problems, interests, and needs of a community through intensively interviewing a small number of individuals who talk at length about the problem of interest. From this stage, planners can learn how clients think about environmental changes which will affect them, what aspects of the problem are important to them, and how they discuss these problems. Once these concerns have been identified, a more structured questionnaire is developed using what has been learned in the open-ended interviews. The structured questionnaire is necessary for gathering the quantitative data for statistical analysis of the distribution of attitudes throughout the population.

In this article we discuss the methodology and present the findings of two studies where it has been utilized. One study, concerning health planning in North Carolina, reveals attitudes toward sources of birth control methods and sources of information about birth control methods. In the other, the design preferences of the Navajo community in Ramah, New Mexico, aid the architects of a new school/community center to design a culturally appropriate structure.

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Figure 1

Heuristic Elicitation Methodology

	Stage I	Stage II	
Instrument	Domain Definition	Beliefs Elicitation	Preference Rankings
Type of Data	Qualitative	Quantitative	Quantitative
Brief Description	Open-ended interviews in which respondents answer a series of interlinked questions which are recorded verbatim to preserve the language and conceptualizations of the respondents.	Structured interviews in which respondents answer yes or no to questions reflecting aspects of the problem of interest expressed in the concept elicitation.	Structured interviews in which respondents rank order, on the basis of their own preferences, items and attributes in the domain of interest.
Type of Data Analysis	Content Analysis	Statistical techniques from frequencies and distributions to multi-dimensional scaling and hierarchical clustering (the latter are optional)	Mean rankings, tests of significance for subgroup differences

The Elicitation Methodology

The Heuristic Elicitation Methodology has been developed to assess the knowledge, beliefs, attitudes, and preferences of a group of people through use of series of interlinked questions in which responses to one question determine the form of subsequent questions. This methodology is useful for a wide range of problems. It has been used to determine perceptions of the role of parents in a federally funded child development program (Harding and Johnson 1971), to study the development of strategies for facilitating the growth of small new businesses in low income areas (Stefflre 1969), to design a program of health services in American Samoa (Harding, Clement, and Lammers 1972; Clement 1974), and to develop guidelines for urban planning in Santa Clara County, California (Harding, Lammers, and Clement 1972). The methodology is represented schematically in Figure 1.

Three data collection instruments are utilized. Following is a description of these components of the methodology: the domain definition, beliefs elicitation, and preference rankings.

Domain Definition

The domain definition is a technique in which a relatively small number of respondents are systematically questioned about a particular area of interest (or domain) in order to provide a basis for further investigation of the various elements in that domain. Respondents are asked to discuss a problem and its constituent parts in the open-ended manner described above. The questions which are asked first identify the items in the domain. Subsequent questions determine the attributes of each item in the domain. The questioning helps the investigator discover as many different items in the domain of interest (for example, kinds of housing) and their attributes (i.e., dimensions, features, traits, characteristics) as possible. The responses to these questions are recorded verbatim to discover the language and concepts used by the community to talk about the particular area of interest. The description of the domain in the respondents' own words is important since professionals may use different words and concepts than the community. Information from the domain definition is useful for:

1. developing the structured questionnaires used in the second phase of the study by utilizing language and concepts appropriate to the community; and
2. providing a basis for informed communication between planners and the community.

To illustrate the nature and format of questions used in the domain definition, a set of questions used in the study of sources of birth control methods and information is presented below. The questions for the domain of sources of methods were as follows:

Q1. What are the different places where people get birth control methods?
PROBE What other places are there where people get birth control methods?

Q2. What methods do people get from "*X*"? (X refers to each source of methods elicited in the previous question.)
PROBE What other methods do people get from "*X*"?

Q3. Who would get birth control methods from "*X*"?
PROBE Who else would get birth control methods from "*X*"?

Q4. What's good about getting birth control methods from "*X*"?
PROBE What else is good about getting birth control methods from "*X*"?

Q5. What's bad about getting birth control methods from "*X*"?
PROBE What else is bad about getting birth control methods from "*X*"?

In this set of questions, the initial question generated sources of methods, the second asked what methods could be obtained from each source, the third who would get methods from each source, and the fourth and fifth questions asked for positive and negative attributes associated with each source. Questions 2 - 5 are structured on the basis of the respondent's answers to question 1.

Previous experience (Stefflre 1972; Harding 1973) suggests that a large sample is not necessary for the domain definition phase of the elicitation methodology since this kind of intensive interviewing is designed to exhaust a respondent's perceptions concerning the set of items being studied. Also, as more individuals are interviewed, the responses tend rapidly to become repetitive, particularly among members of a relatively homogeneous population. If care is taken to represent both sexes, different ages, economic levels and, where important, different ethnic groups (or other groups of special interest), the domain definition interviews reveal the range of items and attributes of a well-defined domain relatively quickly. The data from the domain definition are the basis for developing the structured questionnaires involved in the next phase of the research.

Beliefs Elicitation

In this phase of the research methodology, the actual distribution of belief (attitudes, perceptions) throughout the population is studied. Whereas the domain definition involves the discovery of the range of knowledge and attitudes about a particular domain as possessed by a given population, beliefs elicitation determines the extensiveness within the population about such knowledge and attitudes. It is assumed that there may be variability in the population concerning some aspects of the knowledge and attitudes relevant to a particular domain. This variability may be random, or it may correlate with a social role or socioeconomic status of individuals within the population.

Measuring the extensiveness of beliefs within the population requires quantification. The beliefs instruments are therefore constructed so that they can be statistically analyzed. A structured questionnaire is developed using the responses from the open-ended domain definition interviews. Items mentioned most frequently by the community and items of special interest are selected from among all of those mentioned in the domain definition. The characteristics of the items most frequently mentioned in the domain definition are also selected. They are arranged in a matrix of items by attributes (see Figures 2 and 3) such that the two sets of items can be related utilizing standard questions. The respondents are asked to answer yes or no to each question formed by the matrix. For example:

Q1: Do you think that family doctors usually give you information you can trust? Yes or no?

Q2: Do you think that family doctors usually give you complete information? Yes or no?

To analyze the responses in the beliefs matrix, the individual scores for all matrix cells are added together to determine the number of yes responses. These aggregated frequencies form the basis for analyzing the extent of cultural agreement regarding the many relationships between items and attributes.

The quantitative procedures normally used to analyze the beliefs elicitation range from simple frequency counts and distributions for aggregated cells, rows, and columns to more complex statistical analyses such as multi-dimensional scaling and hierarchical clustering techniques. For most analyses, careful study of the frequencies and perhaps certain simple correlational analyses offer the researcher sufficient information upon which to base judgments concerning the design or modification of a program or project. Past experience with the beliefs elicitation indicates that the matrix data tend to stabilize with a sample of about fifty (Harding 1974).

Figure 2

Beliefs Matrix for Sources of Methods: Observed Frequencies
N = 206

	Is inexpensive or free	Makes you embarassed	Speaks on your level	Gives individual attention	Takes a long time to go to	Gives information that suits	Has time for a person	Good for timid person	For low income people	If you worry about health	Source for the upper class	If you have health problems	Is cold or impersonal	A confidential source	A source for teens
Doctor	70	29	149	168	104	186	119	172	97	192	195	183	51	193	115
Fam. Plan.	187	35	184	167	86	170	150	129	194	118	100	93	51	175	154
Friends	163	65	183	154	19	47	157	118	136	49	93	37	53	61	159
Drugstores	87	55	133	102	27	104	53	74	114	91	130	80	98	133	141
Co. Health	193	49	170	133	79	161	106	128	203	133	91	122	85	171	172
Hospital	99	45	130	115	118	159	87	108	138	153	131	149	113	174	114
Col. Tot.	799	278	949	839	433	827	672	729	882	736	740	664	451	907	855
Col. %	7	3	9	8	4	8		7	8	7	7	6	4	8	8

Figure 3

Beliefs Matrix for Sources of Information: Observed Frequencies
N = 200

	Is inexpensive or free	Makes you embarassed	Speaks on your level	Gives individual attention	Information you can trust	Takes a long time to go to	Makes you uncomfortable	Gives information that suits	Has time for a person	A scientific source	Good for timid person	For low income people	Gives complete information	If you worry about health	Source for the upper class	If you have health problems	Is cold or impersonal	A confidential source	A source for teens	Sound information and methods
Doctor	79	30	132	164	182	101	38	175	101	181	147	110	137	179	190	176	59	184	114	184
School	167	78	133	75	139	64	96	103	86	133	90	153	88	44	112	38	104	86	161	86
Magazines	149	25	116	24	81	15	7	51	42	121	160	135	40	46	123	37	109	101	169	82
Parents	176	84	131	174	148	45	92	130	168	52	124	148	69	76	132	54	34	146	103	64
Fam. Plan.	179	32	176	166	185	66	37	178	164	176	157	188	166	127	141	106	56	174	146	180
Friends	171	54	166	137	56	34	61	55	146	24	115	142	31	30	101	26	57	49	160	20
TV Ads	165	34	122	15	65	14	13	39	31	83	122	145	23	33	92	24	125	99	152	61
Drugstores	133	69	136	106	146	30	76	117	68	140	67	132	76	85	113	75	92	119	99	137
Co. Health	185	50	168	139	177	86	44	159	115	167	138	191	157	158	108	141	78	168	152	177
Hospital	114	55	126	126	179	101	68	153	95	178	118	146	151	167	143	163	102	166	114	177
Minister	177	74	144	176	153	43	73	124	180	57	134	159	73	97	130	84	30	173	58	65
Col. Tot.	1695	585	1545	1302	1511	599	605	1284	1195	1312	1372	1649	1011	1042	1385	924	846	1465	1428	1233
Col. %	7	2	6	5	6	2	3	5	5	5	6	7	4	4	6	4	4	6	6	5

Preference Rankings

The preference rankings determine preferences for domain items and attributes. The investigator selects the items and attributes most frequently mentioned in the domain definition and those of special interest to be included in the preference ranking.

The respondents are asked to rank order, on the basis of their own personal preference, the items and the attributes of the domain. The investigator is therefore able to discover which items are most and least preferred by a population, as well as which features of the items are preferred. Preference rankings allow for determination not only of which items are preferred by the majority of the population but also which are undesirable and should therefore be avoided.

The preference ranking analysis includes computation of the mean rank of each item. This is computed by summing the rankings of an item across all respondents and dividing by the number of respondents. The lower the mean rank the closer the item was to being ranked first, or most preferred. (See Figures 4 and 5.)

The aim of the methodology described above is to discover the distribution of knowledge, attitudes, and beliefs throughout a population using survey instruments developed to be sensitive to the needs for preserving and utilizing the specific language and ideas of the community of interest. This is seen as important for the design and implementation of programs and projects which will be culturally appropriate and therefore meet the needs of the people for whom they are designed.

Use of the Methodology in North Carolina

The North Carolina study was recently conducted by the authors at Policy Research and Planning Group with support from the National Institute of Child Health and Human Development. The study concerns attitudes toward contraceptive methods and sources of methods and information. This article refers only to that portion of the study related to sources of contraceptive methods and information.

We were interested in finding out about the sources of birth control methods and sources of information about birth control methods which people in North Carolina know about and utilize. We were also interested in how people perceive and evaluate these sources. One of the purposes of the study was to provide data for the North Carolina State Family Planning Agency for designing new programs and modifying existing ones. The following paragraphs discuss the sources of methods and information familiar to the people in our sample, the attributes they perceived to be associated with each source, and their preferences for both sources and attributes. We suggest some policy recommendations for the State Family Planning Agency based on our analysis and interpretation of these data.

The data were collected in household surveys conducted in Guilford and Rockingham Counties. The age range of respondents was 18-55 for men and 18-50 for women. Care was taken to include respondents of both urban and rural areas, of all income levels, and both blacks and whites and males and females.

In the domain definition phase of the study, open-ended interviews were conducted to determine the sources of contraceptive methods and information which people knew about and the characteristics they associated with each source. A random sample of eighty-two respondents was used. Approximately half were questioned about sources of methods and half about sources of information. Respondents were asked to name all of the sources they could think of and then to discuss each source. They were asked who would use a source, what kinds of methods or information could be

Figure 4
Mean Ranks for Source Preferences

Source	Rank
Family Doctors	1.610
Family Planning Centers	3.133
Hospital Clinics	4.038
County Health Clinics	4.092
Drugstores	6.072
Parents	6.092
Schools	7.028
Preachers or Ministers	7.753
Friends or Neighbors	8.056
Magazines	8.521
TV ads	9.604

obtained from a source, and what was good and bad about each source.

The domain definition interviews generated the following list of sources of birth control methods, in order of times mentioned: doctor, health department, drugstore, machines (in gas stations, truckstops, etc.), hospitals, stores, friends, welfare, nurse, relatives, college dispensary, street, and black market. For the sample population, "doctor" meant the family doctor, not the gynecologist. This was apparent from the phrasings used. The various terms included physician, the family doctor, personal doctor, and the family physician. The health department referred to the county family planning clinic. Phrasings for this source included health clinic, clinic, social service, county health facility, and family planning clinic.

The sources of information about birth control methods elicited in the domain definition interviews, in order of times mentioned were: health department, doctor, schools, magazines, TV, reading, preacher, drugstore, relatives, hospitals, newspaper, friends, educational material, Planned Parenthood, and college dispensary. This domain is similar to the previous one of sources of methods, but includes some additional sources.

Analysis of the verbatim responses indicated that there are four basic criteria by which a source is evaluated:

1. the degree to which a source allows an individual to achieve the basic goals of obtaining birth control methods of good quality and/or complete, accurate, up-to-date information on sources and advice about which method is appropriate for the individual;
2. the availability of an authoritative, knowledgeable person to whom questions can be addressed;
3. the capacity of the source to provide the user with personal, individualized attention; and
4. the degree to which the source allows the individual to feel comfortable while utilizing the source, i.e., to avoid embarrassment and to maintain confidentiality and privacy.

For example, of all of the sources of birth control methods, the family doctor was evaluated most positively by the majority of respondents. He was seen as the source most competent, scientific, and well-trained. Equally important is that he knows the client personally, provides individualized attention, is available to talk and answer questions, and gives a careful physical examination. Verbatim responses which suggest that the doctor helps the individual in the basic goals of obtaining methods and advice include:

> "the doctor will give the right thing"; "you're getting the latest and most well-developed product"; "any persons who go to their doctor would get information even without asking"; "he can brief you on use and misuse and side effects"; "you could get what is best suited to your system—what is better for you to use."

The perceived competency, personal attention, and confidentiality of the doctor were expressed as:

> "he's educated"; "people feel that doctors know best"; "you feel more safe with a doctor"; "doctor knows the body"; "definitely reliable"; "he knows you better"; "he usually examines the patient first"; "I think if you have questions you can always go back"; "the doctor knows more about you and your family"; "the doctor provides follow-up if you develop problems"; "he can be available to give you advice if the methods fails"; "he will explain a lot more"; "it's confidential."

The preference ranking task combined sources of methods and sources of information into one domain of sources and was completed by 608 respondents. Respondent preferences for sources, with the mean rank for each source, are presented in Figure 4. It can be seen that the "professional" sources are by far the most preferred, and that the family doctor is indisputably the number one source. The least preferred sources are those of the mass media, with parents, school, preacher and friends intermediate. Clearly respondents prefer knowledgeable, authoritative people with whom they can directly interact in learning about, choosing, and obtaining birth control.

Preferences for attributes of sources appear in Figure 5. They underscore the preference for medically-oriented sources, and sources with whom the individual may have a personal relationship. The most preferred attribute of a source was "gives medically sound methods or information," consistent with people's preferences for the family doctor and the family planning center. A source which gives methods and information of high quality and suited to the individual was next most preferred, followed closely by "usually gives you individualized attention." The least preferred attributes, "might be cold or impersonal" and "usually makes people feel embarrassed," are not unexpected since birth control is a very personal matter. These considerations were more important to the population sampled than cost and convenience.

The beliefs elicitation and preference rankings taken together can be analyzed to ascertain in a detailed way

what it is that people prefer or reject in a source. The sources of information matrix was completed by 200 respondents and the sources of methods matrix by 206 respondents.

The family doctor, the most preferred source, can be seen to be associated with the most preferred attributes of sources (see beliefs matrix, Figures 2 and 3). Nearly all respondents in the sample agreed that "he gives you medically sound information," and that "he gives you information and methods you can trust" and "methods that suit you best." The doctor is also most likely to give individualized attention. Of all the sources, the family doctor was least likely to make people feel embarrassed, or to be cold or impersonal.

The family planning center appeared second in the preference rankings, followed by hospital clinic and county health clinic (see Figure 4). These sources were also highly associated with the most preferred attributes and lacked the negative attributes, although the family planning center tended to be evaluated more positively overall than the other two.

Since the family planning center and the clinics were seen as sharing the same positive attributes of the family doctor and lacking the same negative attributes, we might ask why the family doctor was ranked highest. If we refer again to the beliefs matrix it can be seen that where the family doctor and the clinics most diverged was with respect to questions regarding income and social class. Less than half of the sample found the family doctor to be a source of methods or information for the low-income person. Most agreed that the doctor is a source for middle- or upper-class people. For the clinics, the situation was essentially reversed. Relatively few people considered the doctor to be an inexpensive source, while most thought that the clinics were inexpensive.

These findings suggest that the state family planning clinics are perceived as providing competent service of the same high quality as that provided by a doctor, but that they are stigmatized because they are associated with the low-income person. This interpretation is supported by what we learned during the domain definition.

Figure 5

Mean Ranks for Attributes of Sources

Attribute	Rank
A source of information or methods that:	
Gives medically sound information	2.964
Gives information you can trust	3.064
Gives information or recommendations that suit you best	4.002
Gives individualized attention	4.956
Is confidential	5.474
Has time to spend with a person	5.577
Is scientific	5.713
Speaks on the same level as you do	5.862
Is inexpensive or free	8.163
Takes a long time to go to	10.229
Is cold or impersonal	10.863
Makes people feel embarassed	11.005

Many people stated that the clinics are an alternative to the family doctor only if one cannot afford the doctor's fees. Reflecting this idea are verbatims such as:

> "usually if you can't afford a family physician you can get the kind of birth control that you want and not have to pay anything"; "it's for people who can't afford doctors"; "if you couldn't afford a regular doctor."

Some responses reflected the feeling that there is stigma attached to having to utilize publicly supported clinics:

> "makes people feel ashamed they can't pay a doctor"; "that it is free is bad for some people"; "it's for people who get welfare checks"; "it provides for people who can't provide for themselves."

Since the North Carolina State Family Planning Agency is in fact for the low-income person, it seems that the stigma attached to it will be difficult to overcome. However, the findings from this study indicate that family planning centers and hospital clinics are more positively evaluated by the sample population than is the county health clinic. This would suggest that family planning services should be offered separately from the county health clinic, either in conjunction with a hospital clinic, or independently. This recommendation suggests long-range restructuring of the state program. Orienting family planning services away from institutions associated with welfare, such as the county health clinic, would seem to provide services which will be more positively perceived and hence more utilized.

"This would suggest that family planning services should be offered separately from the county health clinic, either in conjunction with a hospital clinic, or independently."

The past experience of the State Family Planning Agency with respect to Guilford and Rockingham counties suggests that services separate from the county health clinic are more apt to be utilized. Family Planning has facilities in Guilford County which are independent from the county health clinic—five satellite clinics around the county and two regular clinics, one in Greensboro and one in High Point. In Rockingham County, all family planning services are provided through the county health clinics.

In Guilford County, a large percentage of the state's estimated target population of eligible women is served. In 1976, 67.3% of the target population received services from the family planning clinics. In Rockingham County, only 10.8% of the target population was reached. While these differences may be due to a number of factors, it seems that future plans for family planning services should take into account the fact that

people seem to prefer family planning centers to county health clinics and that they evaluate family planning centers more positively than county health clinics.

In terms of educational efforts which might be initiated by the State Family Planning Agency, this study suggests that North Carolina people are most likely to find personal interaction with a professional medical source the most appropriate source of information about birth control.

The low ratings given to media sources in the preference rankings have important implications for educational programs. Magazines and television advertisements were the least preferred sources of information. Less than half of the sample population thought that magazines and television advertisements "usually give you information you can trust," information that "suits you best" or "complete information." More importantly, these sources were not perceived by most respondents as providing "medically sound information" (the most preferred attribute).

At present, Rockingham County Family Planning has not developed an educational curriculum or instituted a program to systematically inform prospective users of their family planning services. In Guilford County, there is an educational program. New mothers in hospitals are contacted about family planning services. Newlyweds are given pamphlets. Nurses doing follow-up work in the community refer new clients to Family Planning. Television and radio advertisements describe the services available.

The findings from our study suggest that the development of an educational program for Rockingham County and modification of the existing program in Guilford County should stress interpersonal contact with prospective and continuing family planning clients. Since the evaluation of media sources was definitely negative in the North Carolina sample, it would seem that time and money might be better spent personally contacting people about family planning, even though a limited number of people could be reached. Providing the kind of complete information which people request in a face-to-face situation in which questions can be asked and information "that suits you best" can be obtained by the individual should be an important goal of State Family Planning. Guilford County's educational efforts already seem to have moved in this direction with staff members personally contacting new mothers, newlyweds, and others. About 20% of all new clients in Guilford County are recruited now by staff members, which suggests that this approach is a successful one.

As can be seen in Figure 4, schools did not rank very high as a source, although schools are potentially an important source of information for teenagers. In view of the fact that teenage pregnancy is now considered by population experts to be a serious problem, and teenage pregnancy rates in the Southeast are quite high (Kantner 1975), educational programs in high schools seem to be in order. This North Carolina sample did not seem opposed, in principle, to schools as a source of information about birth control methods. They were ranked very closely after parents, and ahead of ministers, in the preference rankings. However, schools are not now regarded as particularly worthy sources of information. Less than half the respondents agreed that schools give complete information or medically sound information. Some of the responses in the domain definition suggest that people are willing to accept schools as a source of information about birth control methods but that they are suspicious of school programs as they now stand:

> "if it's presented well and taught at the right level, at the right age, it should helpfully eliminate problems with birth control later"; "information is available early before trouble starts";

but,

> "information may be faulty"; "sex should be taught so that there's no shame, but that it's not something to be flaunted either, and it isn't always taught that way."

Our study suggests that an appropriate educational program developed by schools would present information that is medically-oriented and deals carefully and thoroughly with the health aspects of birth control methods. Emphasis should be placed on the scientific credence of the information and its value to the student as information which he or she can use to understand and evaluate birth control methods.

Architectural Planning Study in New Mexico

In this study an architectural firm was hired by the Navajo community in Ramah, New Mexico, to design a community-controlled learning center (Harding, Clement, and Lammers 1973). The architects realized that they lacked knowledge of Navajo culture and values. They were unsure of how to design a structure suitable for the community which would be using it. Because the architects were concerned with designing a culturally appropriate facility, they decided to incorporate a study utilizing the elicitation methodology into their research plans. By doing this, they would have concrete information about Navajo needs and preferences which could be used in the design process.

> "The data on design features indicated that the Navajos wanted soft, smooth textures and surfaces in their buildings. . ."

The data collected in the study were used to determine perceptions of and preferences for building features, uses, and types, and architectural styles. The study was conducted in two phases. In the first phase, domain definition interviews were conducted to discover possible uses to which the facility would be put since the buildings were to be utilized as a community learning and resource center as well as a school. Various uses were suggested by respondents, including education

services at the levels of pre-school, elementary school, high school, and adult education. Suggested services included housing and eating facilities for students and teachers. Respondents also recommended that the facilities be used for provision of certain types of health care, athletic events, and for learning traditional Navajo skills such as tanning, dyeing, leatherwork, silversmithing, and weaving.

In the second phase of the study, the information gathered in the first phase was used to obtain more quantifiable data on community needs and preferences. The Navajo community's preferences for uses of the learning center established it as a place for academic and vocational activities, physical education/recreation, a health center, and housing (for students and the school staff). In terms of academic activities, a school for 7th-12th grades was given highest priority, followed by a school for 1st-6th grades.

In addition to the study of attitudes toward uses of the learning center, the second phase of the study examined preferences for design features of the buildings. Pictures, depicting both interiors and exteriors of buildings, were shown to respondents. Five sets of pictures were developed; three of exteriors and two of interiors. Each respondent was asked to pick from a set of pictures the one picture most liked and the one picture least liked. For each picture selected, the respondent was asked what was most liked about that picture and what was least liked. The data from this part of the study was analyzed to provide the architects with detailed information about respondent preferences for specific design features such as windows, surfacing, and landscaping. A few examples illustrate the type of information gathered in this part of the study.

The data on design features indicated that the Navajos wanted soft, smooth textures and surfaces in their buildings, unlike the traditional rough interiors of the Navajo hogan, or house. Windows were very important, again unlike the traditional hogan with no windows. People wanted to be able to see out to enjoy the view, but they did not wish to be viewed by persons outside the building. Height was a complex dimension. There was some preference for a two-story structure because it was impressive; however, many respondents seemed to have a vague sense that multi-story buildings are dangerous. Landscaping, including grass, trees, and flowers, was regarded as important although the use of fountains and pools was not.

Information such as this, and the information on building uses, was utilized by the architects in their plans. The plans for the learning center included space for a high school, an elementary school, a gymnasium with facilities for athletic events and community meetings, housing for teachers, and an administrative area. Space was thus built and utilized according to the general priorities expressed in the preference rankings, with the exception of the health center which was not incorporated due to budget constraints. The first design of the learning center presented to the Navajo community by the architects was enthusiastically received and approved, and no further designs were requested. This savings alone was almost enough to pay for the study of community attitudes and preferences. The Navajos have retained the architects for additional construction following a new appropriation from Congress for further building.

Summary

This paper has presented a brief description of the Heuristic Elicitation methodology and examples of its use in the areas of health planning and architectural design. The methodology aims to determine how a community perceives and evaluates programs or projects and to systematically study the beliefs and attitudes of the people in the community so that planners and policy-makers can incorporate them into the development and modification of their program plans.

It is hoped that future planning research will strive to systematically determine community beliefs, attitudes, and preferences relating to programs and services. The more systematically this is done, and the more routinely such analysis is utilized as input into project design and implementation, the more we can hope to expect production of goods and services which are socially and culturally appropriate for the individuals for whom they are intended.

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Norman B. Axler

Solid Waste as a Supplemental Fuel for Power Plants in North Carolina

An insignificant portion of the electricity generated in North Carolina is derived from either local or renewable sources. Most of the electricity used in the state is generated either by coal or nuclear power. Both of these fuels are becoming increasingly expensive, are unrenewable, and must be imported into North Carolina. A renewable source of energy would be preferred in that future supplies of these conventional fuels are uncertain. A local fuel source would be desirable because the chance of interruption of supply by national or international political events or by adverse weather conditions would be less likely, and an energy source possessing these characteristics might result in lower costs.

Municipal solid waste has been suggested as a resource that the urban areas of the state can supply which has these desirable characteristics. It is a material that is already collected by municipalities and private industries, and in the recent past the amount of municipal solid waste has tended to grow faster than the population. Also, its heating value is approximately half that of coal (5,000 or more BTU/lb for prepared solid waste versus about 11,000 BTU/lb for coal), and has been increasing as the composition of refuse changes. Although municipal solid waste is not truly a renewable resource, the majority of the materials which constitute it, such as paper, food, yard wastes, and other recoverable materials, are largely renewable.

Municipal solid waste is usually considered a nuisance rather than a resource. The typical system of collection and disposal of refuse in a landfill can be expensive and politically controversial. Aside from removing a potential health hazard, this system provides no positive or economic benefits to municipalities to offset the costs. An energy or materials recovery system would require a major capital expenditure and increased operating costs, but the system would provide revenues to offset part of those costs and would reduce the need for landfill sites and operations. Some other necessary conditions for a successful energy recovery system are sufficient levels of technical expertise, a willingness to implement a relatively new concept, and a volume of solid waste sufficiently high to justify the investments.

One important consideration is to determine which level of government is most appropriate for administration of the system. Local governments in North Carolina probably do not have the capability or desire to consider energy or materials recovery. They also may believe that such systems are feasible only in major metropolitan cities such as New York or Chicago. The state is probably unwilling to become directly involved in the collection or processing of solid wastes from municipalities because of the diversity of local conditions and the traditional role of local government in solid waste handling. However, multicounty planning regions are taking an increased role in organizing regional collection and handling systems which can take advantage of economies of scale. The particular regions in North Carolina which would be most suited for a refuse-derived fuel (RDF) system are discussed below.

There are a variety of technologies to convert solid waste into energy. These technologies result in any of five different energy products: electricity, steam (for direct use), solid fuel, liquid fuel, or gaseous fuel. All these approaches are being pursued and are in various stages of development in different parts of the country (see Figure 1). One particular system, the use of solid waste as a supplemental fuel to coal in power plants, is the focus of this article because it is already commercially operational in some U.S. cities and appears to be well suited to existing institutional arrangements. While it is not an ultimate solution to either energy or solid waste problems, the system is available now for use. An RDF system relies on relatively simple and conventional technology. The system generally requires a cooperative arrangement between electric utility companies and local collectors of solid waste. The arrangement operates to the advantage of both interests, as it provides additional fuel for power companies (and improves their relations with the local community) while it reduces landfill operations for the waste collectors. This article explores how this technology could be adapted to the needs of the state and to the technical and economic capabilities of the power companies which operate in the state.

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The RDF System

The key to the RDF system is its reliance on conventional boiler technology. Prepared solid waste is used as a supplementary fuel in boilers that currently burn coal. Coal remains the primary fuel, with solid waste providing up to 20% of the heat input to the boiler, or up to about 35% of the fuel input by weight. Although many European and some U.S. systems burn 100% solid waste, these systems suffer from corrosion problems which are avoided by keeping solid waste as a supplement rather than the primary fuel. Corrosion problems occur because solid waste is non-homogeneous and burns unevenly. Since coal remains the primary fuel in the RDF system, virtually any existing coal-burning boiler can be adapted, with fairly minor modifications.

The most unfamiliar, and potentially expensive, part of the RDF process is the preparation of the refuse prior to burning. Figure 2 shows a typical system for preparing solid waste as fuel. Most coal-burning boilers in this country are designed to burn pulverized coal suspended in air for a short time. For the solid waste to burn in air along with the coal, it must be shredded into small particles, usually less than 1½ inches in diameter. Additionally, metals and glass are usually removed from the refuse by magnetic belts and by air classifiers which separate heavy from light materials. Removal of metals reduces corrosion and increases the heat value of the remaining waste on a per pound basis because the metal itself is incombustible. Removal also allows for resale of these materials, which can significantly reduce the net costs of processing the refuse.

To get a rough idea of the volume of solid waste that would be burned by a power plant using the RDF system, consider a typical modern power plant with a rated capacity of 2,000 megawatts. Assume an annual capacity factor of 60% (equivalent to running at full capacity 60% of the time) and a heat rate (the amount of heat input required to produce each kilowatt-hour) of 9,500 BTU/kwh, both typical figures for power plants. On an average day, the power plant would generate 28.8×10^6 kwh, and would require 273.6×10^9 BTU of heat input. If coal alone were used as a fuel, with an average heating

Figure 1

Energy Recovery Technology and Products

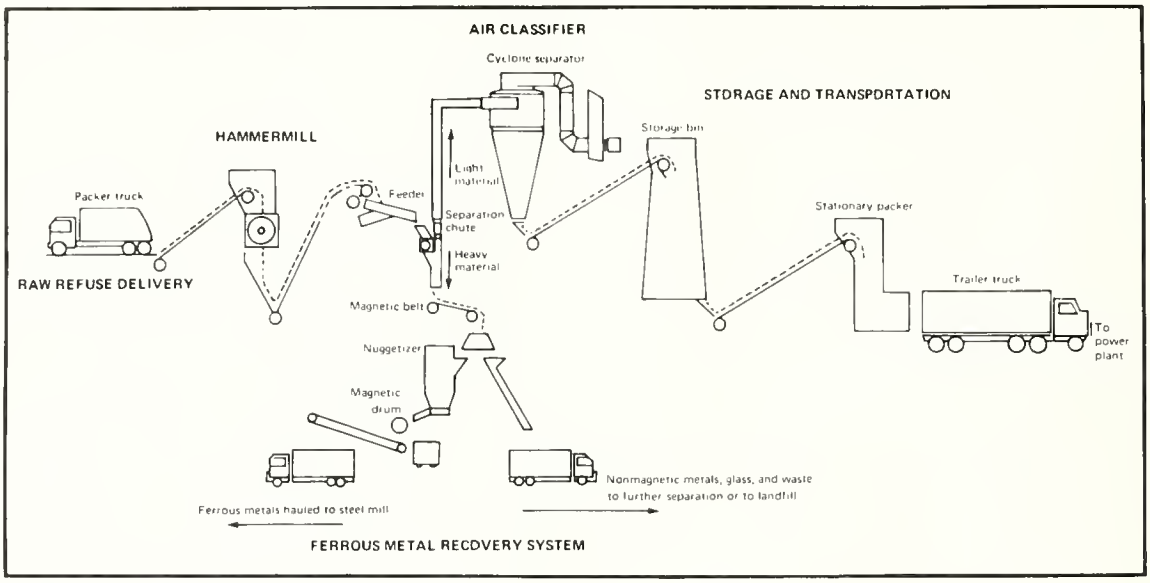
	PRODUCT / TECHNOLOGY	ELECTRICITY	STEAM (for use other than generating electricity)	SOLID FUEL (for use other than in producing steam or electricity)	GASEOUS FUEL	LIQUID FUEL
COMMERCIALLY OPERATIONAL	WATERWALL COMBUSTION (MASS BURNING)	Used extensively in Europe and Japan	Braintree, Mass (O) Harrisburg, Pa (O) Norfolk, Va (O) Chicago, Ill (O) Nashville, Tenn (O) Portsmouth, Va (C) Saugus, Mass (S) Montreal, Can. (O) Quebec, Can (O)	N/At	N/A	N/A
	(SEMI-SUSPENSION)	Hempstead, N Y (C) Dade Co.,Fla (D)	Hamilton, Ont (O) Tokyo, Japan (O) Akron, Ohio (D)	N/A	N/A	N/A
	SOLID FUEL (RDF)	St Louis, Mo (P.O.) St. Louis, Mo (D) Chicago,Ill (C) Ames, Iowa (S) Milwaukee, Wis (C) Monroe County, N Y. (O)	Columbus, Oh (O) Akron, Oh (D)	Los Gatos, Cal (P.O.) Bridgeport, Conn. (D) E Bridgewater, Mass. (S) Palmer Twp., Pa (D)	N/A	N/A
DEVELOPMENTAL	PYROLYSIS					
	GASIFICATION LOW BTU	Luxembourg (C)	Baltimore, Md (S) Grasse, France (C)	By-Product	Possible	N/A
	MED. BTU	Possible	Possible	N/A	S Charleston,W Va (P.O.)	N/A
	LIQUIFICATION	Possible	Possible	By-Product	N/A	San Diego County, Cal (P,C)
	CONVERSION					
	LANDFILL	Los Angeles, Cal (O,P)	Possible	N/A	Los Angeles, Cal (O) Phoenix, Ariz (S)	
	REACTOR	Possible	Possible	By-Product	Franklin, Oh (P) Pompano Beach, Fla (P-D)	N/A
EXPERIMENTAL	WASTE FIRED GAS TURBINE	Menlo Park, Cal (P)	By-Product	N/A	N/A	N/A

*Operating status is designated as
P—Pilot or Demonstration
D—Design
C—Construction
O—Operational
S—Start-up
†N/A—Not Applicable

Source: Levy and Rigo 1976, p. 6

Figure 2

Processing Plant for Solid Waste, St. Louis Project



Source: Levy 1974, p. 7

could be provided by about 5,470 tons of prepared solid waste, with about 5,000 BTU/lb. More typically, solid value of 11,000 BTU/lb, then about 12,440 tons per day would be required. Alternatively, 20% of the heat input waste might provide about 10% of the heat input, for which 2,740 tons would be required. In this case, only 11,190 tons of coal would be required, resulting in a reduction of coal use by about 1,250 tons. At the approximate current price of coal, about $25 per ton, the coal savings, or the value of the solid waste as a fuel, would be $31,250 per day or $11,400,000 per year. Of course, extra costs associated with using the RDF must be subtracted from these values to determine the true value of the RDF to the utility.

For an individual 1,000 megawatt unit within the plant, the solid waste requirements would be half those above, or about 1,370 tons per day. For a boiler rated at 125 megawatts, which is about the smallest size unit an electric utility might have burning coal, the solid waste requirements would typically be about 170 tons per day, assuming the RDF accounts for 10% of the heat input to the unit.

These calculations are just for average days at the assumed operating rates. Since the usage of a utility's power plant will vary from day to day, some small amount of storage capacity must be available at the power plant.

U.S. Experience with RDF Systems

In April 1972, in St. Louis, Missouri, operations began on an RDF demonstration project with financial support from the U.S. Environmental Protection Agency. Prepared solid waste was fired in two Union Electric (UE) Company 125 megawatt boilers, providing approximately 10% of the heat input to the boilers. The RDF was processed at a location 18 miles from the power plant and transported in 75 cubic yard trailer trucks (U.S. EPA 1975, p. 36). Ferrous metals were recovered and resold. For every 100 tons of raw solid waste processed, approximately 7 tons of ferrous metals, at a 1974 value of $17 per ton, were recovered, and about 80 tons of usable RDF was produced (U.S. EPA 1974, p. 92). About 300 tons of RDF was fired per 24-hour day, but only on a 5-day per week basis, corresponding to refuse collection days.

The St. Louis facilities were constructed in 1971, and the design and construction costs amounted to $3.3 million. Operation and maintenance costs in the time period May 1972 to June 1975 amounted to $600,000, for a total cost up to June 1975 of $3.9 million, of which Union Electric paid about $950,000, or one quarter (U.S. EPA 1975, p. 87). Operation and maintenance costs for the period July 1972 to November 1974 were $5.90 per ton of solid waste processed, and $8.50 per ton of RDF burned (U.S. EPA 1975, p. 89). However, during this time, the facilities operated at only about 30% of their capabilities, resulting in higher unit costs than would occur during operation at design capacity.

In addition to the operating experience and cost data that the St. Louis project provided, environmental impacts of the system were evaluated as part of EPA's interest in the project. No health problems were reported due to handling of the waste materials. Air emissions were tested independently by the Midwest Research Institute (MRI) and by Union Electric (which tested particulates only). The MRI tests found that gaseous emissions (sulfur oxides, nitrogen oxides, hydrogen chlorides, and mercury vapors) "are not significantly affected by combined firing of waste and coal" (U.S. EPA 1975, p. 89). The MRI and UE tests did not agree on the existence of changes in particulates, so no conclusive statements can be presently made on this topic.

In August 1975, the city of Ames, Iowa, began operations on the first RDF system not funded by the federal government. While the technology was patterned on the St. Louis demonstration, an important institutional difference remained. The Ames boilers are owned by the municipality rather than by a utility company. The city invested $6.3 million, including land, equipment, and start-up expenses. During the year 1976, the plant processed only 41,000 tons of refuse, or less than half its planned capacity. First year operating expenses were $1.15 million, which was considered to be due to new operating experience. Revenues for the first year totalled $450,000, of which $100,000 was from resale of metals and $319,000 was a noncash revenue credit for the fuel value of the RDF (which the municipality delivers to itself). Net costs for the first year of operation amounted to $17 per ton of refuse (Even *et al.* 1977).

Projects of a higher scale are operating or being built in other locations around the country. A Milwaukee system, with refuse processing by the American Can Company and burning of RDF by Wisconsin Electric, has a rated capacity of 1,600 tons of refuse per day, but is reportedly not in full-scale operation yet. Chicago is starting to transform 700 tons of refuse per day into fuel pellets which it sells to Commonwealth Edison. Other cities involved in design or construction of RDF processing facilities include Rochester, N.Y., Bridgeport, Conn., St. Petersburg-Clearwater, Florida, and New York City.

Electricity Generation in North Carolina

Almost all the electricity in the state is generated by two investor-owned utility companies, Duke Power and Carolina Power and Light. Both companies rely on coal for a majority of their electricity production. However, both companies have adopted policies of shifting to an increasing share of power generated by nuclear reactors over the next ten years. Carolina Power and Light's expansion plans include a mixture of coal and nuclear plants, while Duke Power plans to construct only nuclear power plants in the next ten years. While these decisions are subject to change as the result of economic changes or of government policies, they are reasonable to use as a basis for determining which power plant locations are likely to be suitable for using RDF. If the existing decisions stand, then the only power plants in the state which could use solid waste as a supplemental fuel are the existing coal-fired plants, with the exception of CP & L's planned Mayo plant in Person County.

There are currently fourteen power plants in the state that burn coal (some burn oil or gas in addition), ranging in size from 12.5 to 2,280 megawatts of capacity (see Figure 3). Some of these plants are old units with high operating costs that are used only at times of peak electrical demand. For an energy recovery system to be worth implementing, the power plant must be operating enough of the time to burn a substantial amount of solid waste, thereby achieving savings of large amounts of coal and paying back any capital costs of modifying boilers. A rule of thumb used by utility companies is that the plant is not suitable for burning solid waste unless it is used for at least 50 % of its rated annual capacity (Bostian 1976, p. 4). This is not a hard-and-fast rule and is subject to exceptions depending on the circumstances.

Figure 3

Existing and Planned Coal-Burning Power Plants

North Carolina, 1977

Plant	Location	Company	Rated Capacity MW	Net Generation GWH	Capacity Factor 1977
Allen	Belmont	Duke	1,140	5,217.5	52.3%
Belews Creek	Walnut Cove	Duke	2,280	12,388.7	62.0
Buck	Spencer	Duke	364	1,436.8	45.1
Cliffside	Cliffside	Duke	770	3,789.9	56.2
Dan River	Eden	Duke	272	982.4	41.2
Marshall	Terrell	Duke	2,025	10,218.6	57.6
Riverbend	Mount Holly	Duke	448	1,704.6	43.4
Asheville	Skyland	CP & L	394	1,876.5	54.4
Cape Fear	Moncure	CP & L	323	1,163.9	41.1
Lee	Goldsboro	CP & L	421	2,005.5	54.4
Roxboro	Roxboro	CP & L	1,735	8,540.8	56.2
Sutton	Wilmington	CP & L	598	2,218.0	42.3
Weatherspoon	Lumberton	CP & L	177	744.7	48.0
Mayo (planned)	Person County	CP & L 1-1982	720	----	---
		2-1985	720		
Roxboro (expansion)	Roxboro	CP & L 1980	720	----	---
Chapel Hill	Chapel Hill	UNC	12.5	32.7	29.9

Sources: Duke Power Company Steam Production Department; Carolina Power and Light Fossil Fuel Section; UNC Utilities Division

Three power plants owned by Duke Power—Buck, Dan River, and Riverbend—are unsuitable for energy recovery on the basis of their 1977 capacity factors. Four others—Allen, Belews Creek, Cliffside, and Marshall—are potential locations for an RDF system. Of these four, the Belews Creek and Marshall power plants are the newest and largest, and are used to higher capacities than the others. Because of their high efficiency, the usage of Belews Creek and Marshall is not likely to drop when and if new nuclear units become part of Duke's generating system.

For Carolina Power and Light, three existing coal-burning plants had 1977 capacity factors over 50%—Asheville, Lee, and Roxboro. The Brunswick nuclear plant had its first full year of operation in 1977. The Asheville plant, in CP & L's isolated service area in the western part of the state, is probably not greatly affected by the introduction of the Brunswick plant. The Roxboro plant is relatively new and is therefore less affected by the Brunswick plant than an older, marginally efficient plant. The three remaining coal-fired plants operated by CP & L all had 1977 capacity factors under 50%, tentatively screening them out. Weatherspoon's usage was the closest to 50%, making this small power plant a marginal possibility for an RDF system. CP & L's planned Mayo power plant would be a potential location for an RDF system in the near future.

Solid Waste Generation in North Carolina

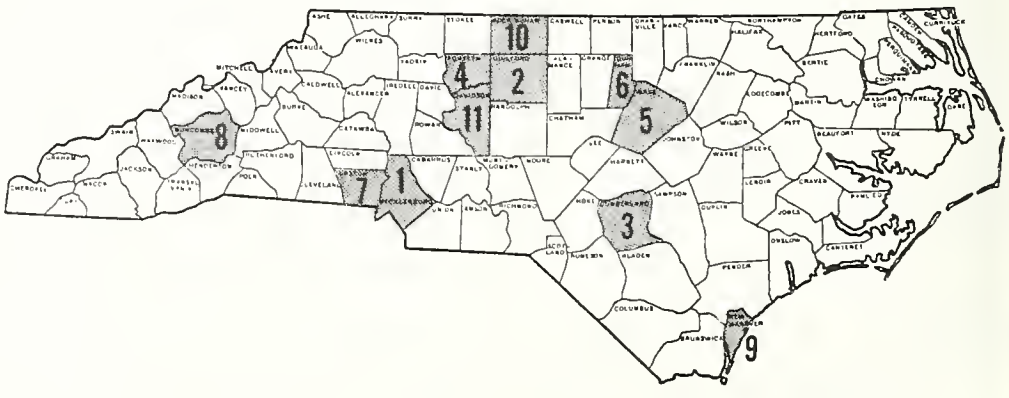
Solid waste generation roughly parallels population levels, with urban residents generally generating more solid wastes per person than rural residents. In addition, a higher percentage of urban solid waste is collected by public agencies than rural solid waste. North Carolina does not have any large cities, but it does have a number of moderate sized cities. Most of these cities are located in the Piedmont section of the state. Of the located in the Piedmont and three are located outside seven Standard Metropolitan Statistical Areas (SMSAs) designated by the Census Bureau in the state, four are the Piedmont. The Fayetteville SMSA is closest to the Piedmont, located only about sixty miles from Raleigh. Raleigh forms one end of a crescent of cities in the Piedmont that extends to Charlotte-Gastonia area and continues into South Carolina. The total distance from end to end of the North Carolina portion of the urban crescent is about 160 miles.

Estimates of solid waste generation in North Carolina should not rely on national averages but on local surveys which weigh samples and do not use volume to estimate weight. The only statewide, comprehensive survey of solid waste generation in North Carolina was made in 1967-68 (Office of Solid Waste and Vector Control 1975). The survey results give the quantities of solid waste collected by each county. The results of the survey are somewhat inaccurate because of the absence of weighing facilities at most waste disposal sites around the state. Nevertheless, in the absence of better data, the survey results give an estimate of solid waste generation for 1968. Of the eleven counties collecting over 100,000 tons per year (equivalent to about 275 tons per day in 1968), eight were located in the Piedmont section of the state (See Figure 4). Mecklenburg County, which contains the state's largest city, Charlotte, was by far the leading generator of municipal solid waste in the state, with over 400,000 tons per year, according to the survey. Several years later, a local survey based on detailed sampling showed that Mecklenburg County actually generated over 650,000 tons per year (Henningson, Durham and Richardson, Inc. 1972, p. TS-2).

Solid waste generation increases with population growth and with increases in per capita generation. Per capita generation of waste is related to level of production and consumption in the economy, to packaging practices, to the extent of reuse of products, and to the rate at which products become obsolescent or wear out. Historically, per capita generation rates have been rising each year in this country. However, it is not clear whether this trend will continue. But even if per capita

Figure 4

Counties in North Carolina Collecting over 100,000 Tons Solid Waste in 1968, in Rank Order



1. Mecklenburg
2. Guilford
3. Cumberland
4. Forsyth
5. Wake
6. Durham
7. Gaston
8. Buncombe
9. New Hanover
10. Rockingham
11. Davidson

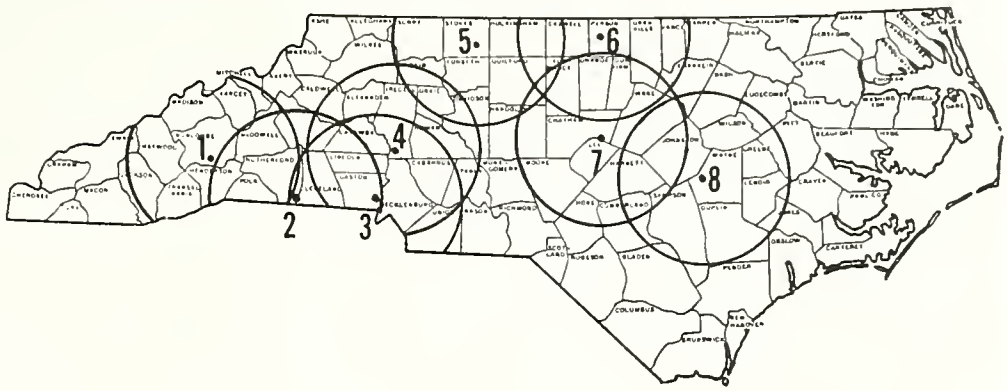
Source: Office of Solid Waste and Vector Control 1973

Figure 5

Approximate Truck Transport Limits Around Power Plants Potentially Suitable for Using Solid Waste as a Supplemental Fuel (50 mile radius around each power plant)

Power Plants Shown:

1. Asheville
2. Cliffside
3. Allen
4. Marshall
5. Belews Creek
6. Roxboro
7. Cape Fear
8. Lee



generation rates stopped rising, North Carolina's population growth would make solid waste an increasing resource.

Energy recovery systems must allow for variations in solid waste generation from day to day and from season to season. Solid waste is generally collected by public agencies on weekdays only. Most areas generate more solid waste in the summer than in the winter, with the difference made up largely of yard wastes. These variations mean the RDF system must anticipate variations in the heating value, moisture content, and recoverable materials in the solid waste. The waste processing system must also screen out bulky items which cannot be shredded, and potentially explosive items, such as gasoline or oil containers, which could ignite during the refuse processing.

Most communities dump these wastes into landfills, which occupy large amounts of land and are politically controversial. Few residents want the landfill to be located near them. The life of existing landfills can be extended by reducing the quantity of waste that is dumped there. Extending the life of a landfill means that the search for new sites can be delayed. Of the material used as input to an RDF system, only about 10% must be returned to a landfill. Of course, bulky items will still have to be sent to landfills.

Matching Solid Waste and Electric Energy Generation

The matching of energy markets with solid waste collection is based on the fuel needs of the power plants and the quantities of solid waste generated in an area. The link between these two factors is the system of transporting wastes from collection points to the processing site and power plant. In North Carolina, truck and rail are the only two methods available for transporting wastes. Trucks are currently used in North Carolina for transporting wastes to disposal sites because of the relatively short distances to landfills. The costs of truck operation limit the range of transport to roughly fifty miles (Dial 1973, p. 160). Beyond that distance, rail haul could be economical, although there are problems involved with rail haul that have discouraged its use. In recent years, rail haul of solid waste has been tested in several projects around the country, and the possibility of rail haul of solid waste in North Carolina as part of an RDF system should be briefly considered.

Rail haul is a more capital-intensive mode of transport than truck transport. In other words, the costs of rail haul do not double as the distance of the haul doubles because operating costs are only a small portion of the total. However, rail cars and other rail equipment are very expensive. Therefore, to make a rail haul of solid waste economical, a large quantity of waste is required. A typical rail car carries 60 to 100 tons of solid waste. If only 100 tons were being transported, the rail car would have to be attached to a regularly scheduled freight train. This scheme would be difficult to implement, as it would be difficult for the railroad company to assure regular and fast delivery of the solid waste. The other alternative is to hire a unit train that would carry only solid waste and deliver it to a specified location.

Martin estimates that the urban areas of the Piedmont crescent in North Carolina will generate between 5,000 and 13,000 tons per day in 1980 (1976, Appendices). If the actual figure is around 10,000 tons per day, this would theoretically be sufficient for over 100 rail cars in a unit train. However, collection of that quantity of solid waste from dispersal points would be difficult. The unit train would have to make stops at various points along the crescent to load solid waste into cars. A significant amount of truck transport would be needed to get the waste to the loading stations, which would be costly. The transfer stations required would also be costly.

The destination of such a unit train could be a processing plant in the Charlotte area. The processing plant could recover metals for resale and prepare wastes for burning in the Marshall and Allen power plants, located in the Charlotte area. With a combined capacity of 3,165 megawatts, the two power plants could burn up to 8,600 tons of solid waste per day, but would typically only be able to burn about 4,500 tons per day. This assumes that every unit in the two plants was utilized, which is unlikely. Unless new power plants were constructed

which could assure that the solid waste could be burned, the market for rail transported solid waste would be insufficient to justify the costs of the rail haul. In addition, having the entire Piedmont crescent rely on two power plants for the utilization of its solid waste could be a problem when one or both of the plants are shut down for repairs or maintenance.

A more modest and decentralized system of transporting solid waste would rely entirely on truck transport and would generally be limited to a fifty mile one-way haul from origin to destination. By locating those power plants potentially suitable for solid waste firing on a map of North Carolina and drawing a circle equivalent to a fifty mile radius, the approximate boundaries of potential service areas for such a system can be determined (see Figure 5). The actual service areas may be less because of road configurations, political boundaries, and economic considerations. It can be seen that the Charlotte-Gastonia area could be served by several power plants in the area. The Belews Creek power plant could serve Winston-Salem, Greensboro, High Point, and possibly Burlington. Moncure, where the Cape Fear plant is located, is within fifty miles of Raleigh, Durham, Chapel Hill, and Fayetteville.

How well would this system match the needs of the power plants with the flow of solid waste from the service area? The Belews Creek power plant, with a capacity of 2,280 megawatts, could burn 3,000 tons of solid waste per day assuming 10% heat input supplied by RDF. The Piedmont Triad Council of Governments has made projections of 1980 solid waste generation of 1,494,700 tons per year, or an average of 4,095 tons per day (Piedmont Triad COG 1973, p. 13). However, it is unlikely that all the waste from the region can be collected and transported to the Belews Creek location because of transportation costs. Of all solid waste generated in the region, 54% or 2,230 tons per day is expected to be in Guilford and Forsyth Counties, which have urban areas not far from the Belews Creek plant. At these levels of waste generation, economies of scale should be realized in the processing operations, resulting in lower unit costs than were present in either St. Louis or Ames, Iowa. This would not eliminate solid waste disposal problems in the Piedmont Triad region, but it would significantly reduce the volume of material for disposal.

The Charlotte area has the Marshall (2,025 megawatts) and Allen (1,140 megawatts) plants to serve it. The Cliffside plant (770 megawatts) is an additional potential user of Charlotte's solid waste, but its location is less favorable than the other two plants. Together, the Marshall and Allen plants could burn about 4,500 tons of solid waste per day. A single refuse-processing plant located between the two power plants could supply RDF to both and would be assured of a use for the RDF even if one of the power plants were shut down. These plants are made up of small units ranging in size from 165 megawatts to 650 megawatts. Therefore, any amount of RDF less than 4,500 tons could be easily handled by utilizing only selected units or by increasing the input of RDF to those units. A 1972 survey of Mecklenburg County's solid waste collections, which was probably

A Refuse-Derived Fuel (RDF) system would extend the life of landfills.

Photo by Blair Pollock

more accurate than the state's 1968 estimate, showed that the county generated about 1,800 tons of solid waste per day. By 1980, that figure was expected to increase by over 50 percent, which would amount to 2,700 tons per day just from this one county (Henningson, Durham and Richardson, Inc. 1972, p. TS-2). With other portions of the region, including Gastonia, Kannapolis, Statesville, and other communities contributing some solid waste, the quantity of RDF available would be sufficient to keep the Marshall and Allen units burning RDF.

Power plants in North Carolina owned by Carolina Power and Light also have opportunities for burning solid waste as supplemental fuel, even though these power plants are not located in the heart of the Piedmont crescent. The plants owned by CP & L tend to be smaller in size than those of Duke Power, and they serve the electrical demands of a more dispersed population. Energy recovery systems for these smaller CP & L plants could become economical, especially if the price of coal rises substantially, and serve the needs of CP & L and the municipalities in its service area. Thus, although RDF systems are not currently as attractive to CP & L as to Duke Power, the possibilities for such systems should still be explored.

The Lee plant in Wayne County has the potential for serving a largely rural population. Its 421 megawatt capacity could burn up to 1,100 tons of solid waste per day. In Wayne County and the six counties immediately surrounding it, about 720 tons per day were generated in 1968. By 1980, that figure will be much higher and would easily be sufficient to fuel the Lee plant. However, if existing collection systems are widely dispersed in this rural county, transportation costs may rule out this system.

The Asheville area has the potential of being served by the CP & L plant at Skyland. Rated at 394 megawatts, the plant could burn up to 1,100 tons per day of solid waste. In 1968, the four counties of Buncombe, Haywood, Henderson, and Transylvania generated about 740 tons per day. By 1980, those counties will probably be generating around 1,000 tons per day. Once again, however, waste generation and collection may be too dispersed in this area to justify a centralized refuse processing system.

The Roxboro plant (and the planned Mayo plant) in Person County is a large, modern, and efficient coal-

burning power plant. These characteristics suit it to use in an RDF system. However, the distance of the plant to Durham or Burlington, the nearest urban areas, is thirty miles or over. The high transport costs that would be involved would be substantial, but this still might prove to be a feasible location for an RDF system.

The Cape Fear power plant at Moncure is in a favorable location for having an assured supply of solid wastes for its burners. With its rated 323 megawatt capacity, it could burn up to 900 tons of solid waste per day at a 20% RDF fuel input rate.

Wake, Durham, and Orange counties generated about 1,100 tons per day in 1968. With Lee, Chatham, Harnett, and Cumberland (including Fayetteville) counties added in, over 2,000 tons of solid waste was generated in the vicinity of Moncure in 1968. Considering population growth, the Moncure plant could be assured of sufficient supply of solid waste. Unfortunately, the usage of the Cape Fear plant is too low to be consistent with the needs of the RDF system, so it cannot be considered a prime candidate.

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In the Charlotte area, a solid waste management study has just been initiated which will consider a RDF system among a variety of disposal and recovery alternatives. The study is being conducted by the Charlotte office of Henningson, Durham and Richardson, the consulting engineering firm which designed the Ames, Iowa refuse processing plant. Because of the existence of several efficient coal-burning plants in that area, a variety of different arrangements of an RDF system are possible and should be considered by that study.

Although these two areas might be best for the first RDF systems in the state, other areas will become feas-

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Conclusion

This article has described a commercially operational technology for generating electricity from municipal solid waste. The technology is developed to the point where prudent utility companies and municipalities can make reasonably secure investments. The economic considerations which will determine the feasibility of refuse-derived fuel systems will vary from area to area, depending particularly on the cost of landfill operations, the quantity of solid waste collected, the cost of processing facilities, and the markets for fuel in utility or municipally-owned power plants. Establishment of such an energy recovery system begins with a dialogue among the interested parties.

This analysis of North Carolina power plants and solid waste generation patterns indicated that the Charlotte and Greensboro-High Point areas are the two urban areas of the state best suited to development of an RDF system. Duke Power Company has just completed an initial study for the city of Greensboro of an RDF system using the Belews Creek power plant. Details of the study are not available while it is being evaluated by the city, but the system is based on a capacity of 1,000 tons per day. Although both units at Belews Creek would be modified to burn RDF, only one of the two units at Belews Creek would burn solid waste at any one time. Processing facilities would be operated by the city, while Duke Power would have only twelve hours storage capacity (500 tons) and would pay the city for the heating value of the fuel provided.

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Although these two areas might be best for the first RDF systems in the state, other areas will become feasible locations if trends favorable to energy recovery continue or accelerate. Foremost among these trends would be an increase in the price of coal. The extent to which the state's power companies switch to nuclear power will also affect the feasibility of RDF systems. If more nuclear power plants are introduced into the electrical generating system, the coal-burning plants will be used less often, and RDF systems will become less attractive. Another factor which will affect the economic feasibility of RDF systems is the price which recoverable metals will bring. These prices have recently been low, probably due to the general slowness of the economy.

In determining the feasibility of an RDF system, it should be remembered that not all the costs of landfill disposal or the usage of coal can be translated into dollars and cents. As waste continues to accumulate at increasing rates, the difficulty of finding landfill sites that are acceptable politically and economically will increase. After the implementation of an energy recovery system, solid waste may cease to be perceived as "garbage" and would become a valued element of the electric generating system of an area.

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